Progress Report

January 13, 2016

Steam Enhanced Extraction at the Former Williams AFB, ST012 Site

Mesa, AZ

TERRATHERM

1. Summary

This report covers the period of operations from Tuesday, January 5, 2016 through Monday, January 11, 2016. The following table provides a summary of the project operational status.

Table 1. Project Summary

	Value	Unit
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)
Area	199,000	square feet (ft^2)
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)
Lower Depth of Treatment	245	ft bgs
Vapor Liquid Treatment Started	09/29/14	
Thermal Operations Started	09/29/14	
Last Process Data Update	01/11/16	
Last Temperature Data Update	01/11/16	
Estimated Total Days of Operation	422	days
Days of Operation	469	days
Days of Operation vs. Estimate	111	percent (%)
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)
Total Energy Used	4,772,713	kWh
Used Electrical Energy vs. Estimate	42	%
Total Steam Injected	285.4	million pounds (lbs)
Projected Total Steam Injection	320	million lbs
Steam Injected Vs Projected	89	%
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	1,011,792	lbs
Total Mass Removed as NAPL	1,270,946	lbs
Average Daily NAPL Mass Removal Last Week	4,600	lbs/day
Total Vapor and Liquid Mass Removal (based on PID readings)	2,282,738	lbs
Average Power Usage Rate Last Week	404	kilowatts (kW)
Average Wellfield Vapor Extraction Rate Last	388	standard cubic feet per minute (scfm)
Average Condensate Production Rate Last Week	0.4	gallons per minute (gpm)
Average Water Extraction Rate Last Week	121	gpm
Total Water Extracted	73,521,108	gallons
Total Recovered Light Non-Aqueous Phase Liquid	193,447	gallons
Average Water Discharge Rate Last Week	198	gpm
Total Treated Water Discharge	98,312,000	gallons

Operational highlights from the past week include:

- On January 5, 2016, water with a sheen was found to be dripping out of an open steam injection manifold valve near MPE CZ-09. Approximately 10-20 gallons of steam condensate mixed with condensed vapors is believed to have dripped onto ground. After the boilers were shut down on December 28, 2015, the steam line valves were left open to allow any pressure or steam condensate to be released from the line. After identifying the water with sheen, operators found three steam wells that had been previously isolated from the manifold to be leaking vapor into the steam injection manifold. It is thought that when Boiler 2 was drained on January 5, 2016, a slight vacuum was generated on the line facilitating the cooled valves to unseat enough for vapor to leak into the steam manifold. The vapor then condensed in the manifold, mixed with the steam condensate and dripped out of the line. Impacted soil was excavated down to asphalt in the area and stockpiled for characterization and off-site disposal.
- The average liquid extraction rate from the formation was approximately 121 gpm for this operational period.
- The complete steam depressurization cycle initiated on December 29, 2015 continued. No steam was injected the past week.
- The net extraction from the formation was equal to the liquid extraction rate (121 gpm).
- Increased NAPL production has been observed during the depressurization cycle.
- Collected process, wellfield and laboratory samples per the sampling schedule.
- Conducted regular maintenance on the treatment system.
- The following MPE wells were identified as requiring maintenance during this operational period:
    - LSZ05
    - LSZ06
    - UWBZ02
    - UWBZ26
    - CZ11*
    - CZ16
    - CZ18

**Temperatures at this MPE well are at boiling – well maintenance will be postponed until temperatures are below boiling due to health and safety concerns.*

2. Vapor Extraction

Figure 1 below shows the vapor extraction rate from the site. Note that the estimated steam extraction rate is a calculated value based on the water generated at the moisture separators after cooling the vapors from the wellfield. Based on energy balance analysis, additional steam is likely being pulled into and condensing in the liquid extraction system. This steam extraction is not measureable and not accounted for in Figure 1. Additionally the wellfield flow is calculated as the difference between the air stripper flows and thermal accelerator influent, and is therefore only an estimate.

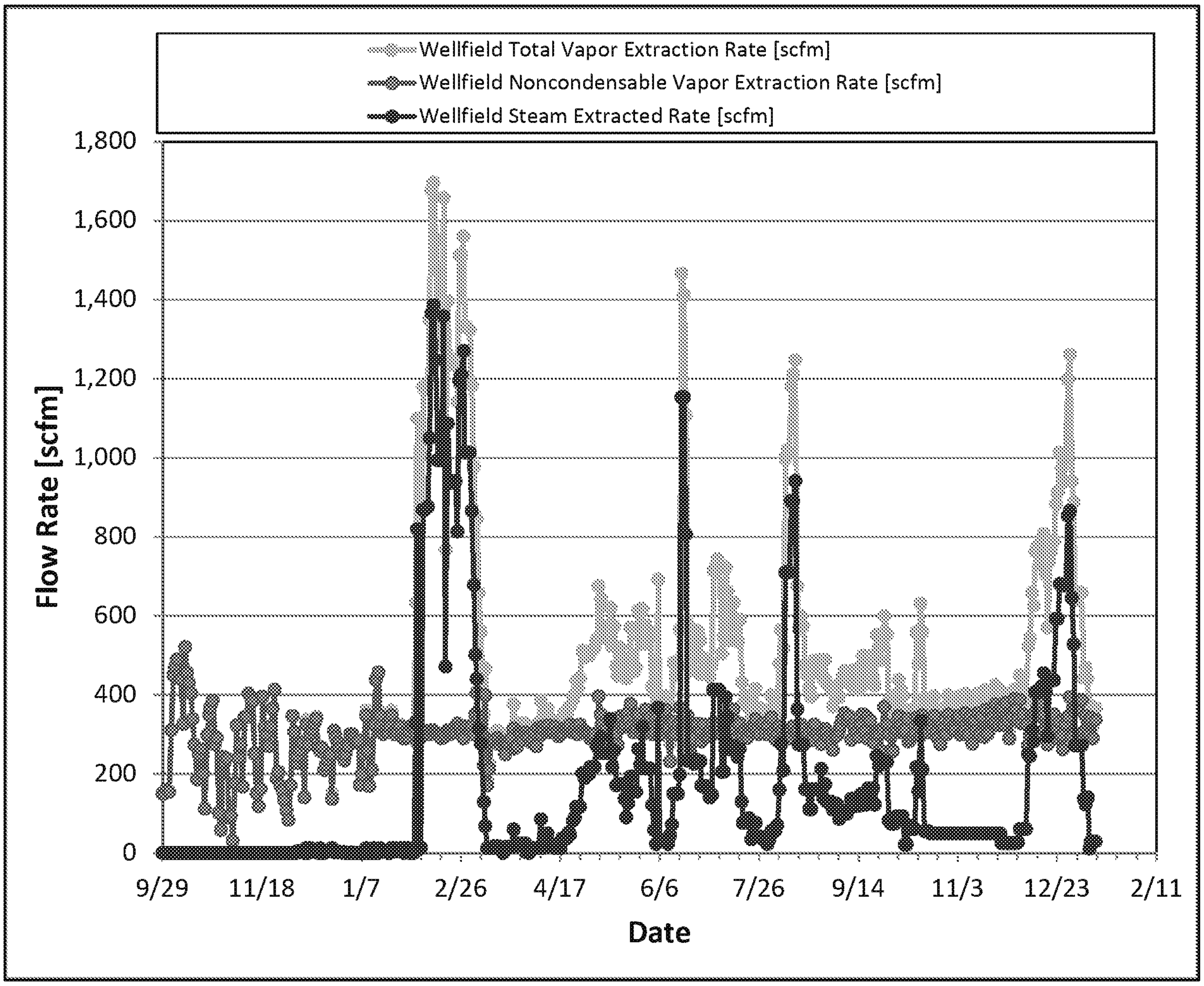

Figure 1. Vapor Extraction Rate

Note: Well SVE01M was tied into the SEE extraction system on June 5, 2015. Wells SVE10M and SVE14M were tied into the SEE extraction system on September 23, 2015.

3. PID Measurements

The following figure depicts the PID concentrations from the wellfield effluent to the effluent of the thermal accelerators collected since the start of operations. Note that PID readings of 0.0 parts per million by volume (ppmV) are shown in the figures as 0.01 ppmV due to the logarithmic scale that does not allow display of 0-values. Accelerator influent readings are interpolated for days where no data is collected, since the value is used in the mass removal calculation.

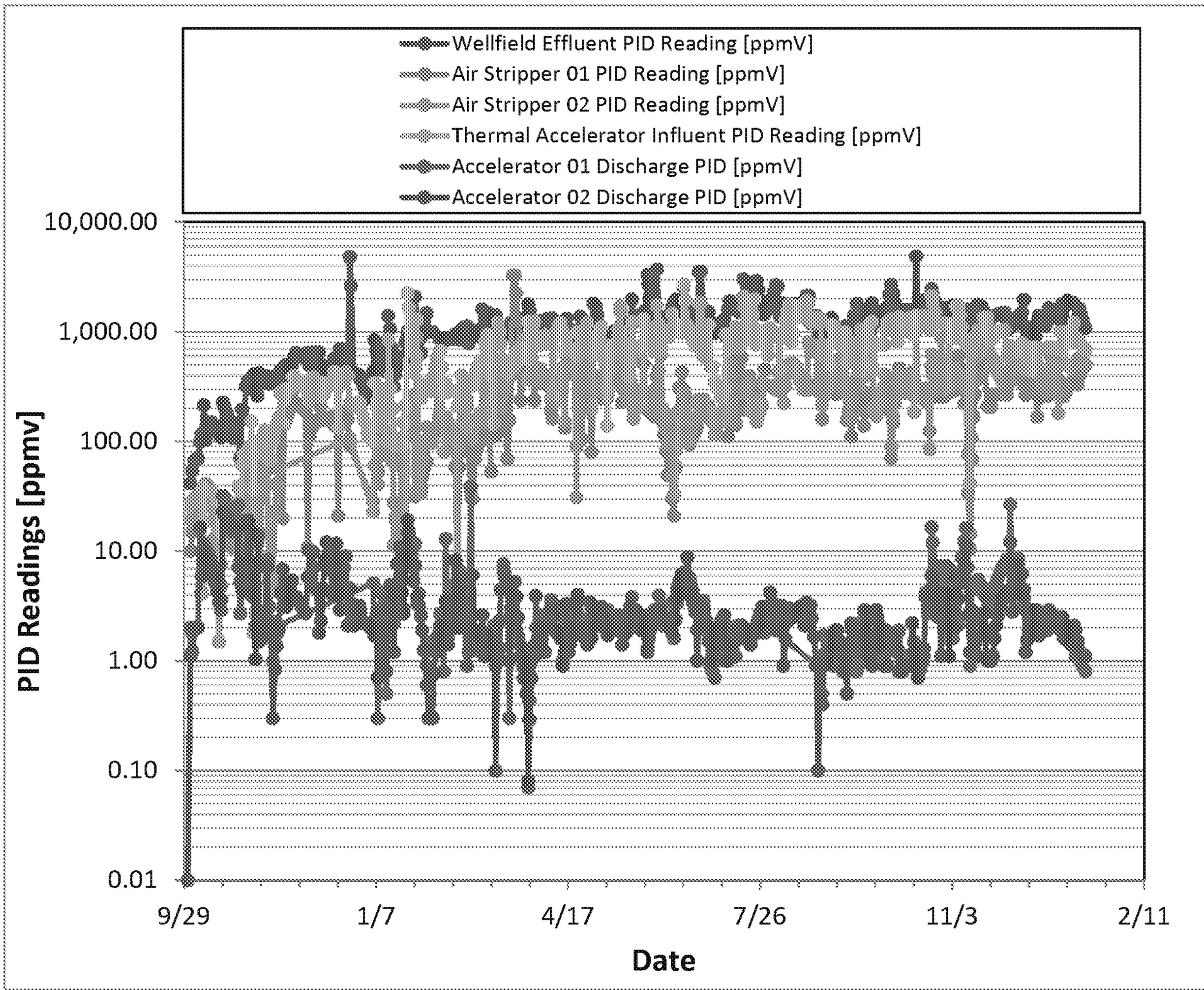

Figure 2. PID Readings

4. Mass Removal

The mass removal is calculated based on the PID and laboratory data collected at the thermal accelerator influent and the LNAPL recovered. The figure also depicts the mass removed based on PID and laboratory data.

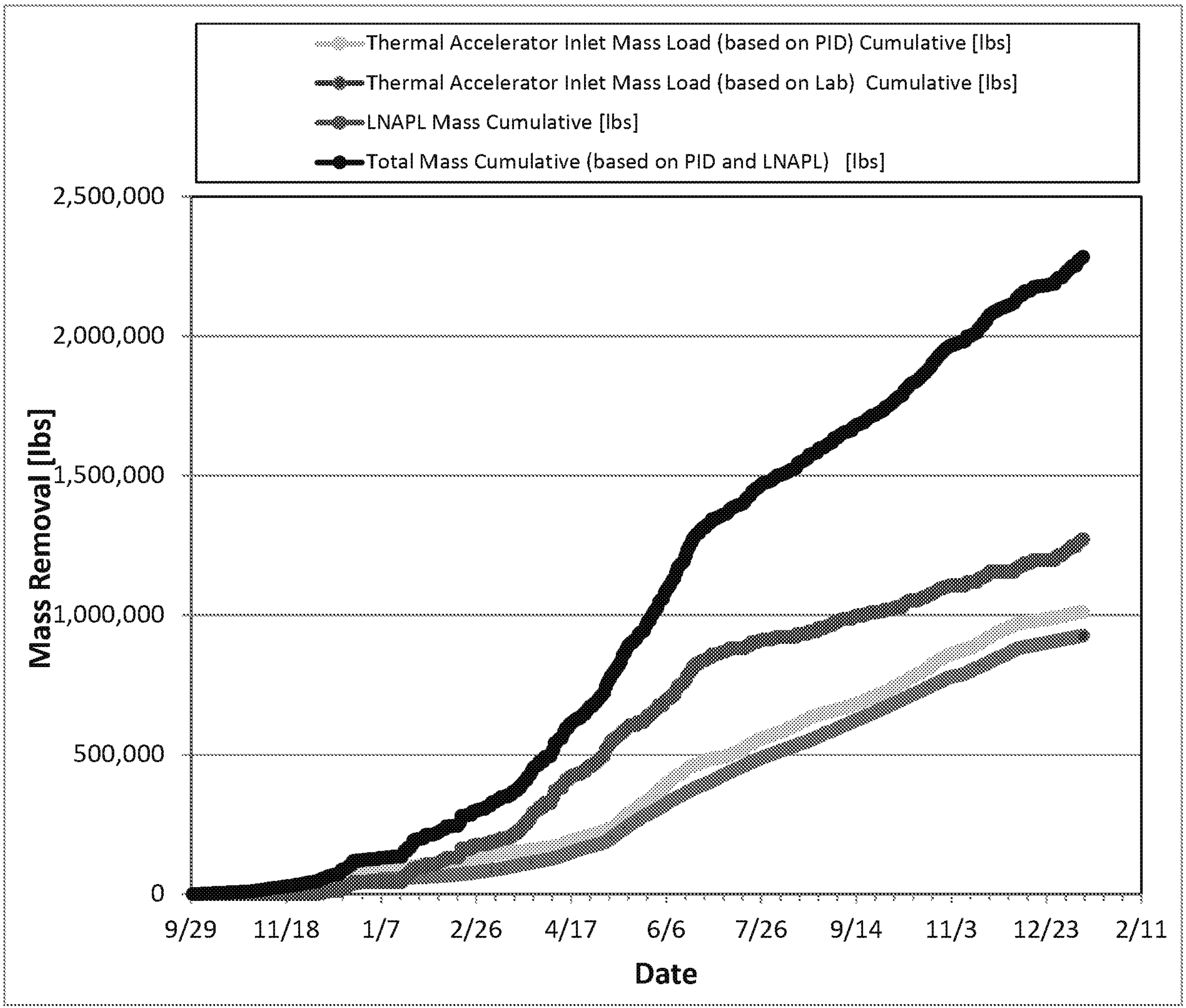

Figure 3. Mass Removal

Note: A NAPL density of 6.57 lbs/gallons is used to convert the NAPL volume to pounds. A molecular weight of 106,168 g/mol (corresponding to xylene) is used to convert PID readings to concentrations.

5. Daily Mass Removed

Figure 4 outlines the daily mass removed as vapor and LNAPL. The total daily mass removed is the combination of vapor and LNAPL. The liquid mass removal is captured in the vapor phase due to the volatilization of liquid contaminants in the air strippers.

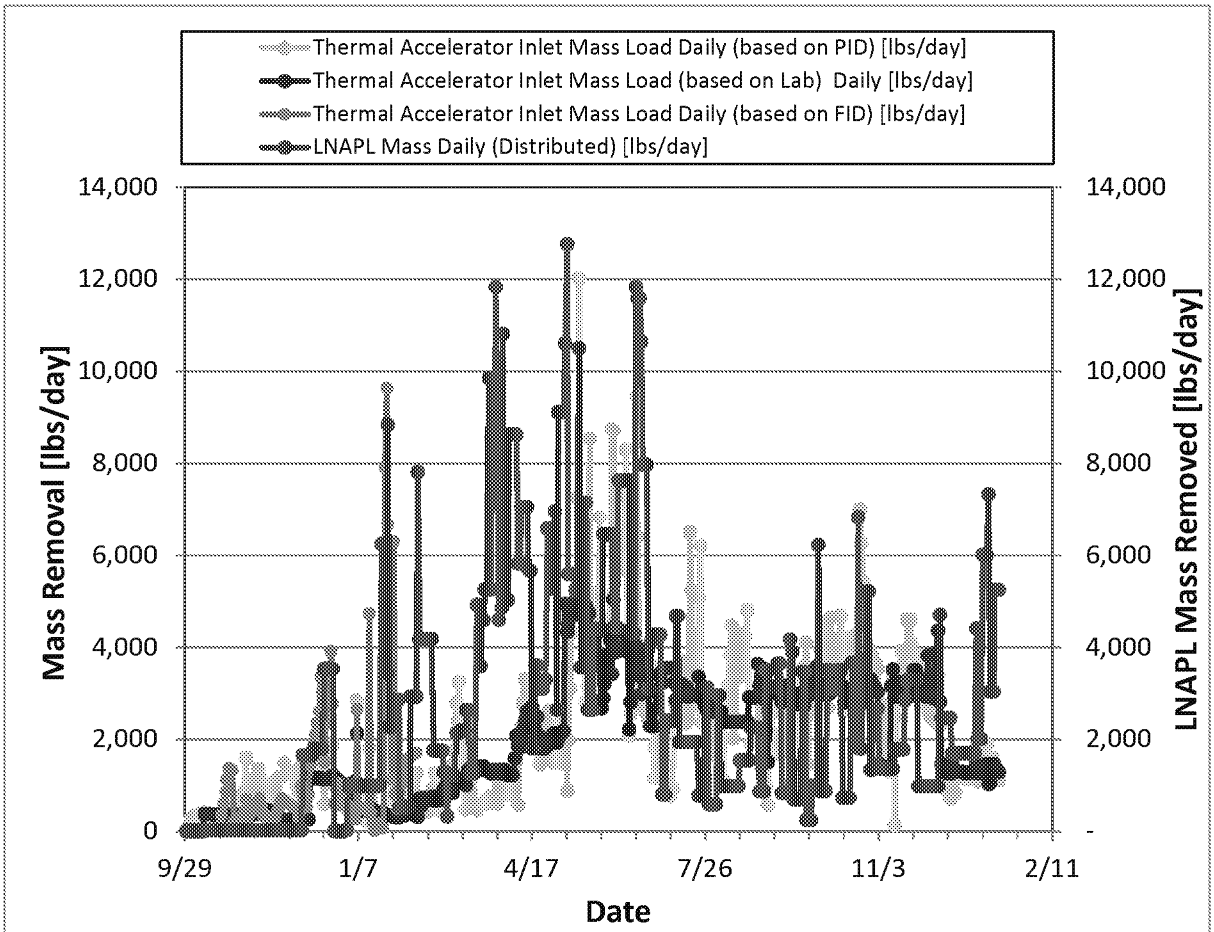

Figure 4. Daily Mass Removed

Note: Laboratory data are not collected daily. The "Thermal Accelerator Inlet Mass Load (based on lab)" is an average daily rate of actual lab data collected. The report has been updated based on lab data received for samples collected through December 9, 2015.

Note that accumulated LNAPL is pumped through the NAPL conditioning system in a batch style process. The LNAPL daily mass removal rate has been calculated by calculating an average daily rate based on the total gallons processed for each batch over the number of days between batches.

6. Power Usage

The cumulative power usage is shown below. All electricity used at the site is utilized to run the process system and steam generators.

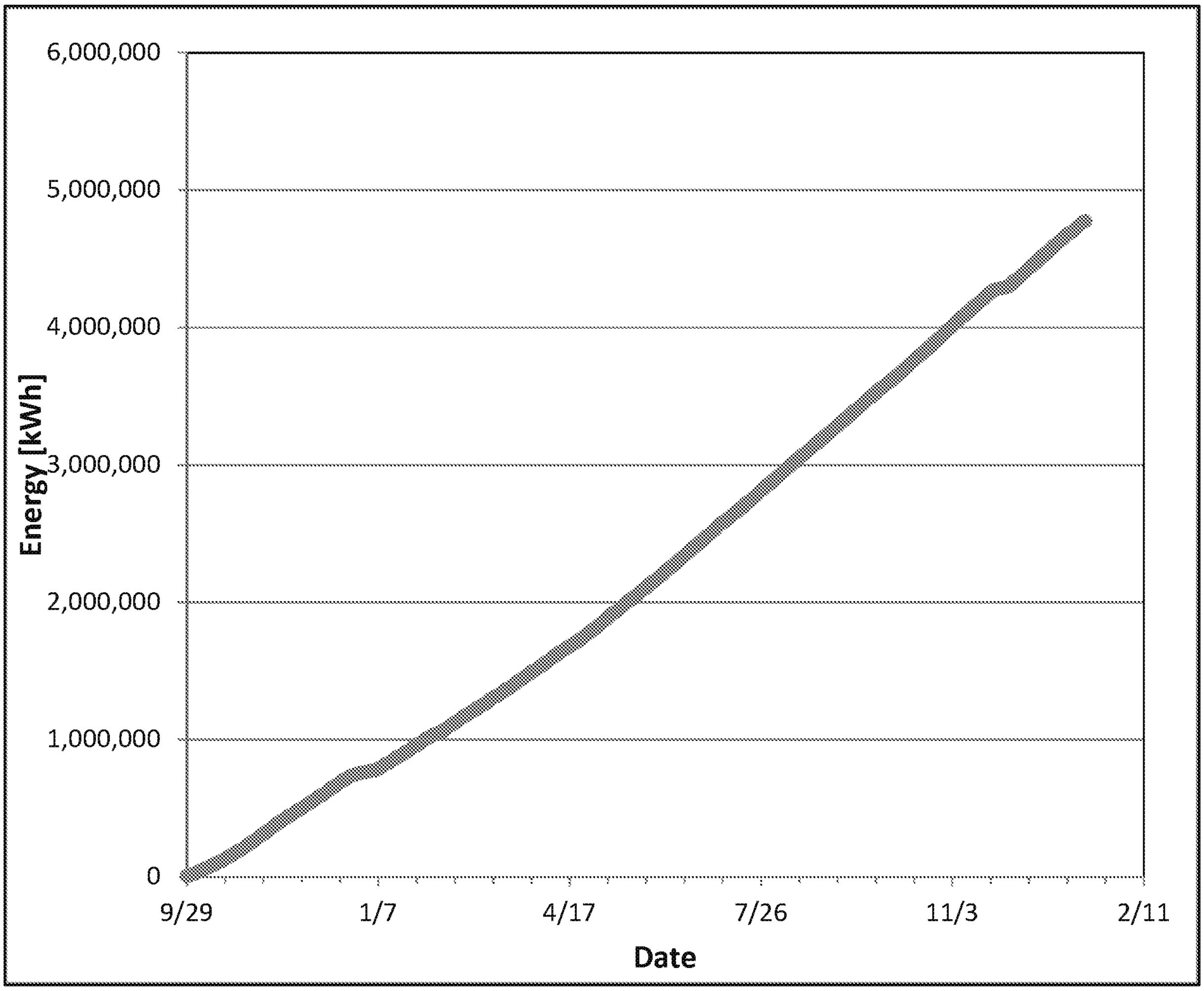

Figure 5. Cumulative Power Usage

7. Average Temperature

A detailed review of thermocouple sensor depths and temperatures over time was performed week ending November 13, 2015. Results of the review and updates are detailed below in Table 2 and Figure 6.

Table 2. Temperature Monitoring Sensor History

Temperature Monitoring Point	Temperature Monitoring Sensor History
TMP01	Well compromised 6/9/2015, select sensors back online 7/15/2015. Well not extended down in the Lower Permeable Zone (LPZ) and LSZ.
TMP03	Well compromised 12/18/15. All sensors offline as of 12/18/15.
TMP04	Well compromised 6/21/2015. Not included in LPZ and LSZ since 6/21/2015.
TMP05	Well compromised 5/6/2015, select sensors back online 7/15/2015. Sensors deeper than 160 ft have not been online since 5/6/2015 and therefore are not included in UWBZ, LPZ and LSZ.
TMP06	Well compromised 3/27/2015, select sensors back online 7/14/2015. On 9/10/2015 all sensors went offline and have been excluded from LPZ and LSZ averages.
TMP07	Well compromised 3/27/2015, select sensors back online 7/14/2015.
TMP08	Well partly compromised 9/11/2015 from 210 ft and down. The 215 and 235 ft sensors are still operating.
TMP09	Well compromised 2/9/2015 before CZ was turned on and UWBZ was up to temperature. The CZ and UWBZ temperatures have been excluded. LSZ temperatures have not been updated since 2/9/2015 (taken out of LSZ average).
TMP12	Sensors from 150 to 170 ft bgs only at ~50C. Brings down the average in CZ and UWBZ.
TMP13	Well compromised 3/27/2015, select sensors back online 4/30/2015. Since 7/1/2015 no sensor deeper than 225 ft has been operational.
TMP15	Well compromised 8/15/2015. 8/15/2015 temperatures assumed from this day.
TMP17	Well compromised 3/27/2015, select sensors back online 6/12/2015 but not reporting properly, total failure 7/16/2015. Depths lower than 235 ft not included in average since well was not at temperature when sensors failed. 7/16/2015 temperatures applied to average since well failed.

The average soil temperatures as degrees Celsius (°C) and degrees Fahrenheit (°F) are shown in the figure below by treatment zone (i.e., LSZ, UWBZ and CZ).

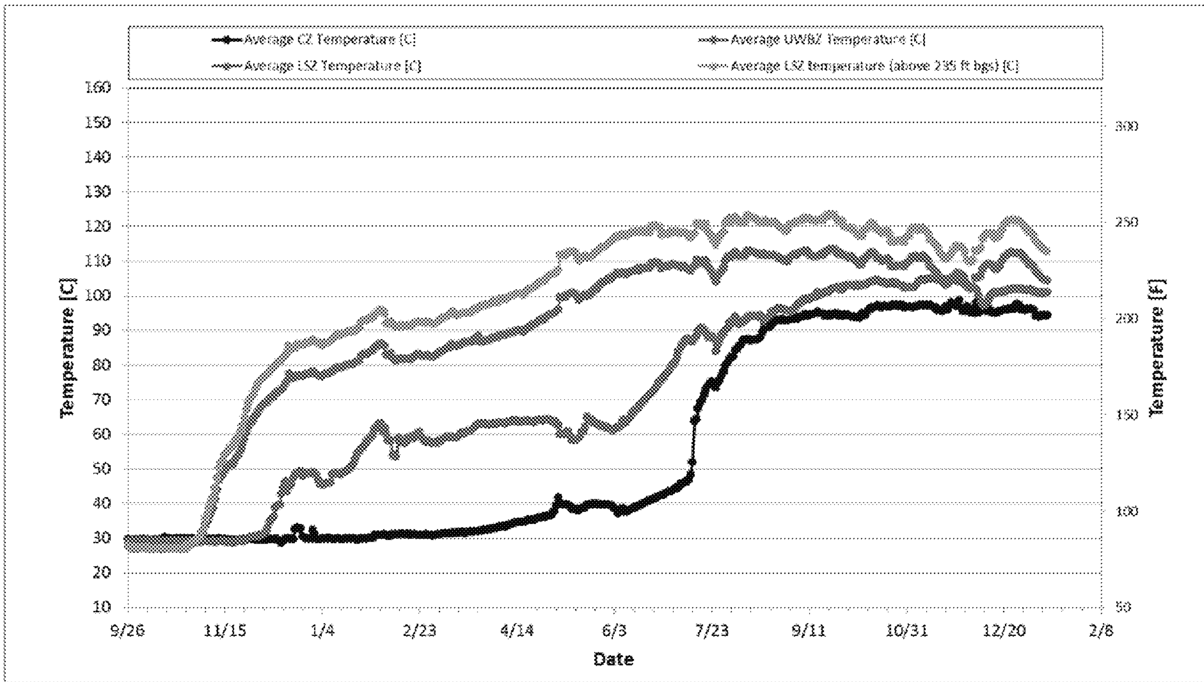

Figure 6. Average Soil Temperatures

Table 3 below provides a breakdown of the maximum average temperatures achieved at individual temperature monitoring points throughout SEE operations. The table below breaks down the average temperatures achieved across the CZ, UWBZ, Lower Permeability Zone (LPZ) and the LSZ to date. The LSZ is further broken down into the average for all LSZ sensors and those LSZ sensors above 235 ft bgs.

Table 3. Temperature Monitoring Point Maximum Depth-Averaged Temperature

	Temperature Monitoring Point Maximum Depth-Averaged Temperature[1] (°C) During SEE Operations by Zone				
Temperature Monitoring Point	**CZ**	**UWBZ**	**LPZ**	**LSZ**	**LSZ (depths above 235 ft bgs)**
TMP01	114.8	130.5	N/A	N/A	N/A
TMP03	N/A	N/A	137.5	114.2	120.7
TMP04	N/A	N/A	103.8	118.8	127.1
TMP05	110.3	N/A	N/A	N/A	N/A
TMP06	N/A	N/A	137.4	135.0	135.9
TMP07	N/A	N/A	134.6	137.2	140.2
TMP08	N/A	N/A	136.6	131.3	135.4
TMP09	N/A	N/A	132.5	134.1	139.3
TMP11	N/A	N/A	110.6	119.1	131.7
TMP12	75.7	90.3	121.8	121.4	131.3
TMP13	102.1	119.8	130.6	138.4	140.0
TMP14	N/A	N/A	133.6	124.3	136.3
TMP15	113.1	123.3	128.7	126.5	135.6
TMP16	N/A	N/A	126.7	120.5	131.0
TMP17	N/A	N/A	135.2	136.9	136.9
Maximum depth-averaged by zone[2]	**103.2**	**116.0**	**128.4**	**127.5**	**134.0**

If N/A, Temperature Monitoring Point has no sensors in that zone

[1] Temperature of the thermocouples across each depth zone are averaged for each TMP and each available time interval and then the maximum value of those averages throughout operations is listed in the table.

[2] Average of maximum depth-averages listed above for all TMPs in each zone.

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8. Vertical and Horizontal Temperature Profiles

The following Figures 7 and 8 show the temperature in °C versus depth profiles for each of the 17 individual temperature monitoring points. Please see Table 2 for an updated temperature monitoring sensor status.

Temperature highlights for the past week include:

- Perimeter well TMP 02 saw a small drop in temperature in the LSZ and holds a current high temperature of 59°C at the 215 ft bgs sensor.
- The 150 ft bgs sensor dropped from 104°C to 95°C for TMP 05.
- TMP 08 saw varying decreasing temperatures across the CZ, UWBZ and LSZ. The current high temp for this array is 75°C at the 185 ft bgs depth.
- Perimeter well TMP 10 has remained relatively stable.
- TMP 11 decreased minimally in temperature towards the middle of each treatment zone.
- A number of the TMPs remained relatively stable.

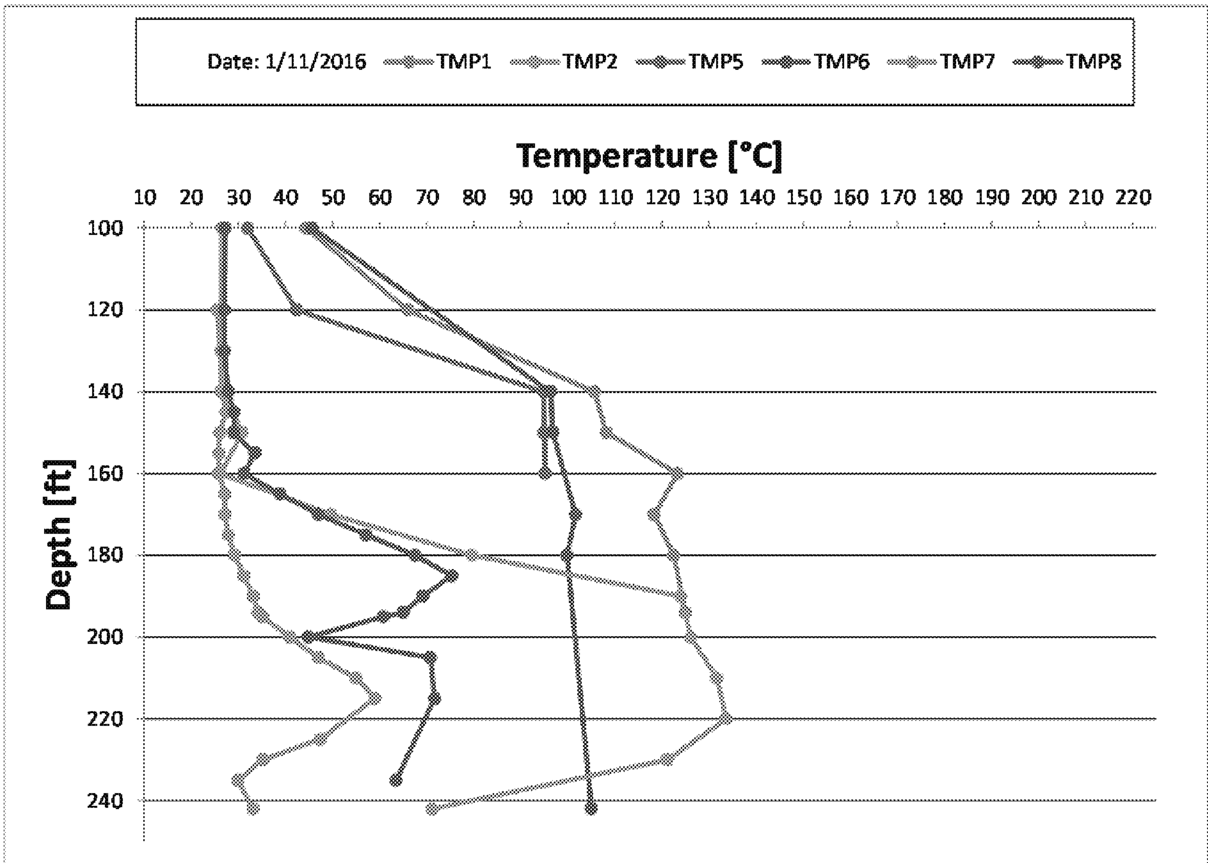

Figure 7. Vertical Temperature Profiles (TMP01 through TMP08)

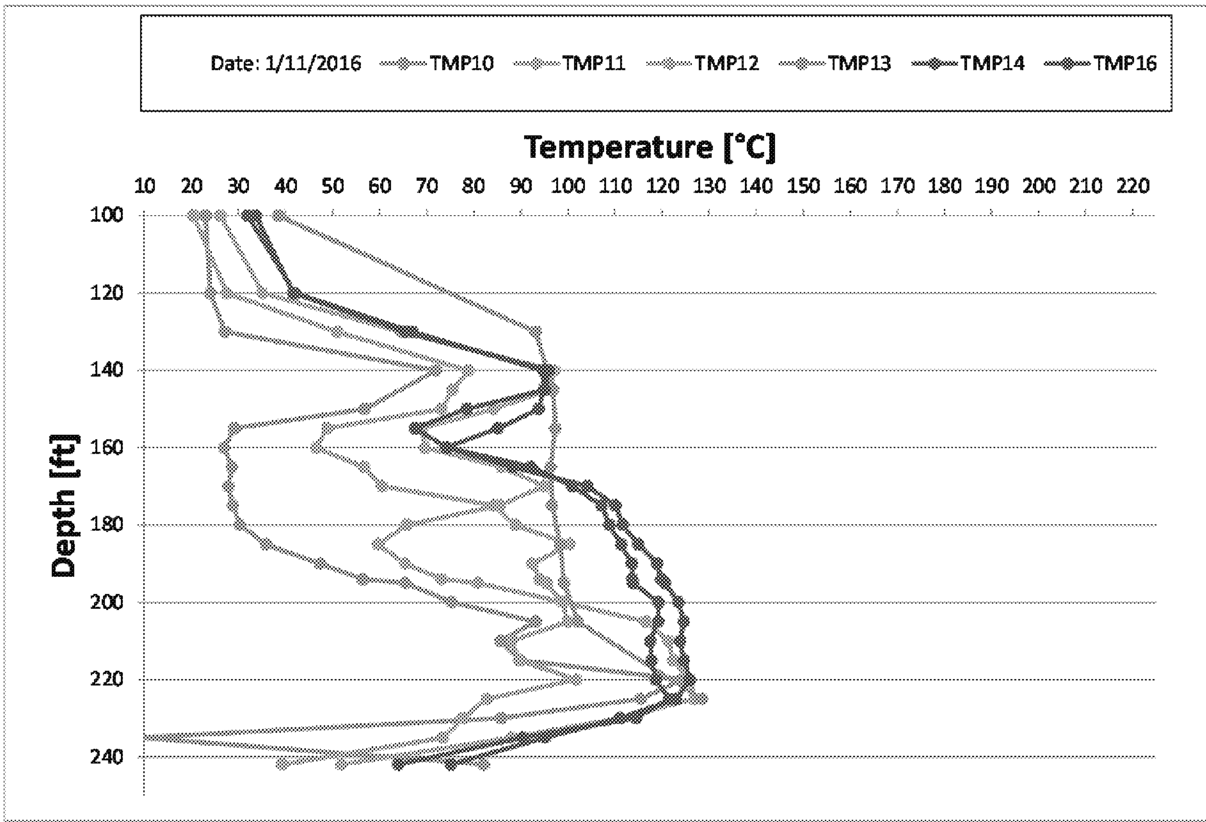

Figure 8. Vertical Temperature Profiles (TMP09 through TMP17)

Figures 9-12 show the horizontal temperature distribution across the site in four depth intervals.

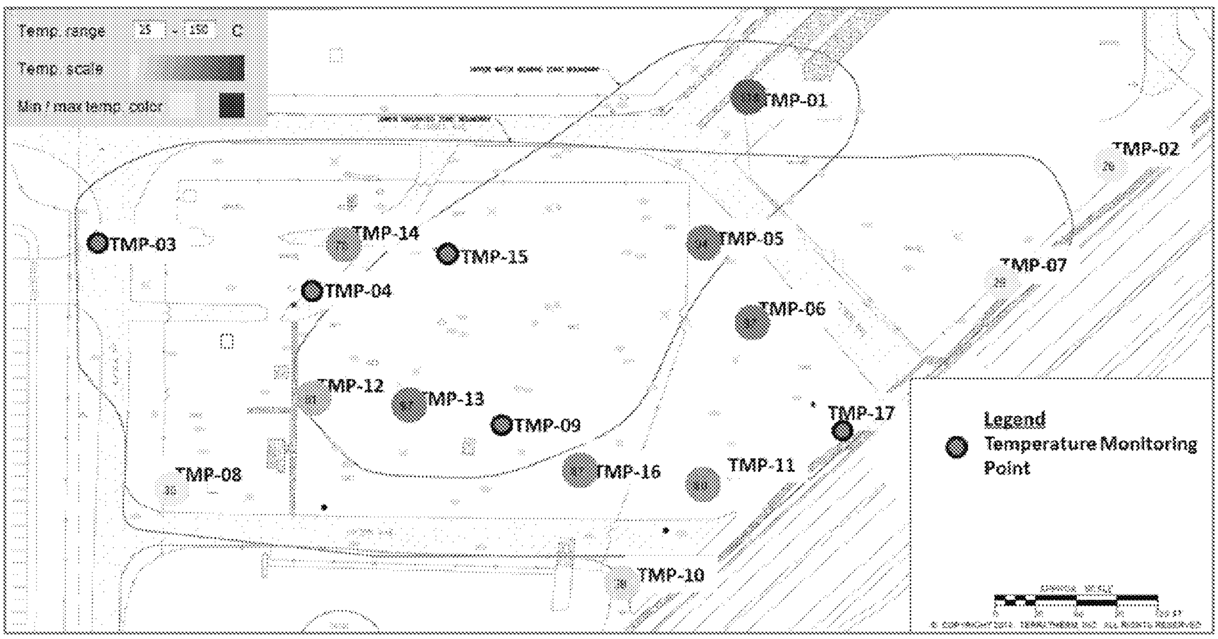

Figure 9. Horizontal Temperature Distribution across the CZ (145-160 ft bgs) (temperatures shown in °C)

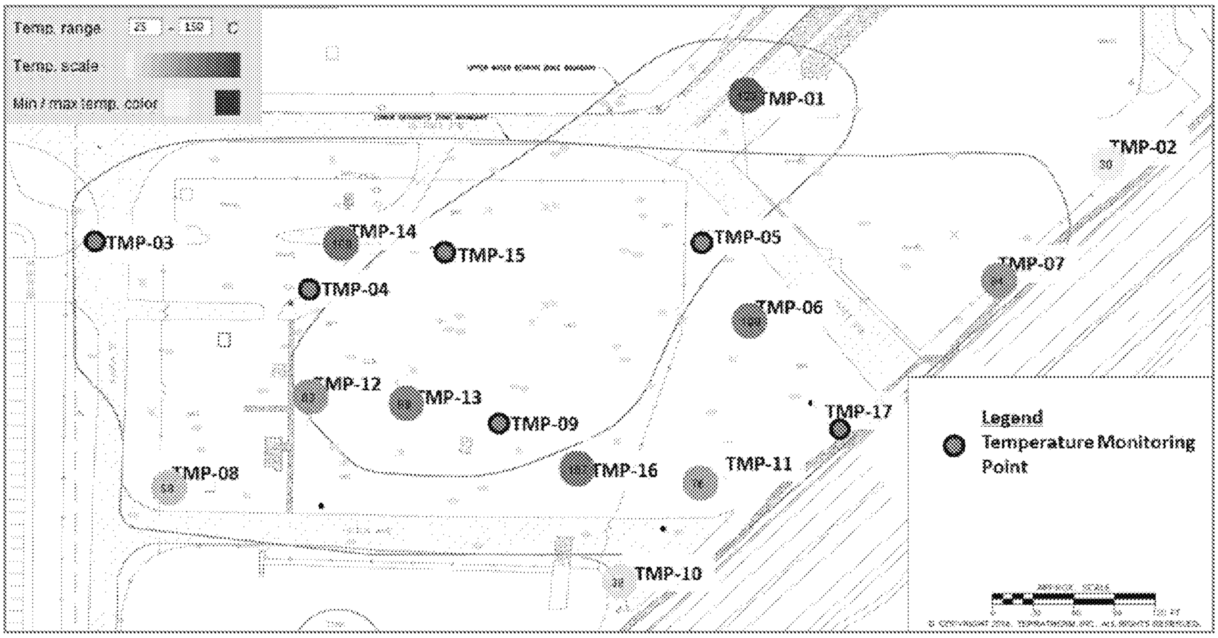

Figure 10. Horizontal Temperature Distribution across the UWBZ (161-195 ft bgs) (temperatures shown in °C)

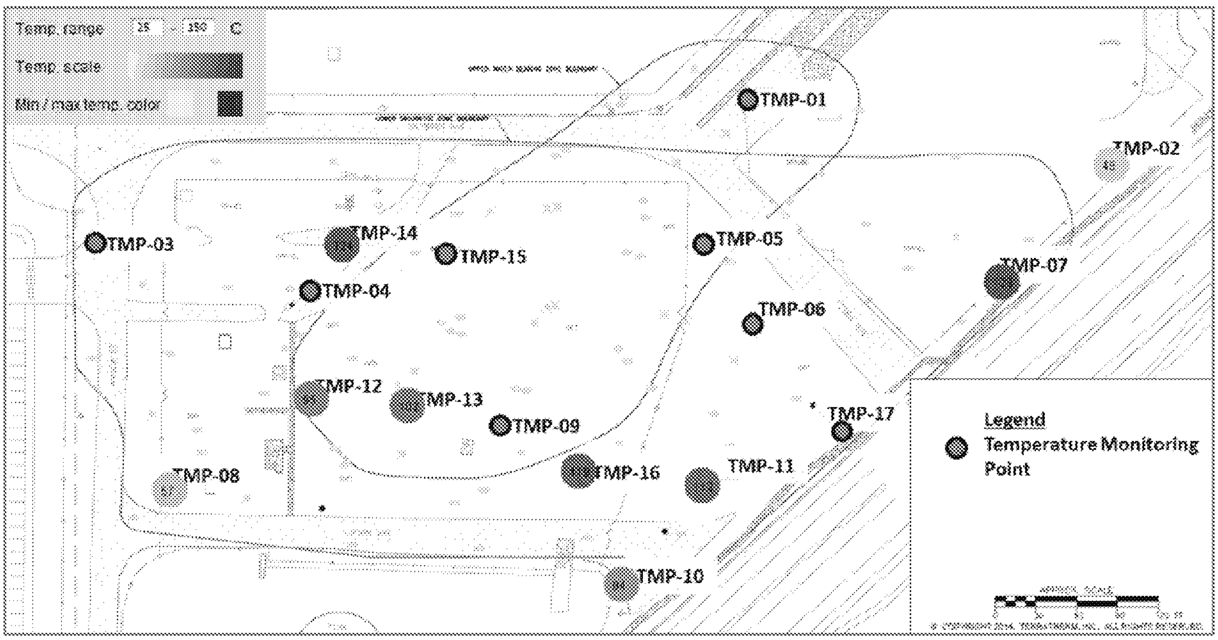

Figure 11. Horizontal Temperature Distribution across the Lower Permeable Zone (196-210 ft bgs) (temperatures shown in °C)

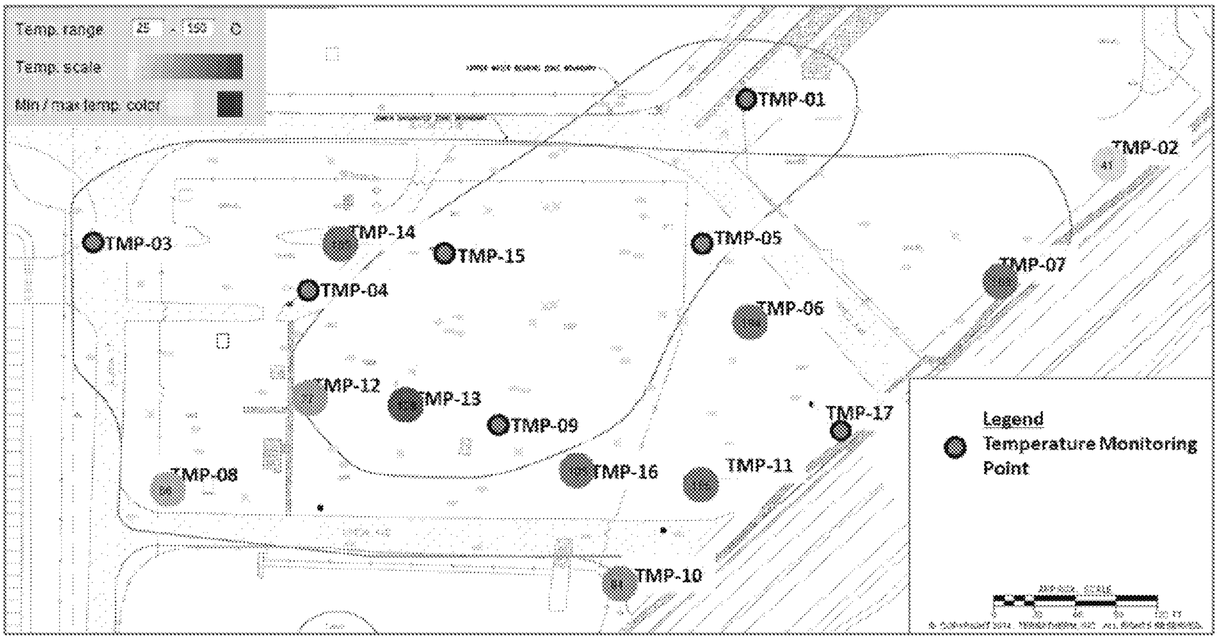

Figure 12. Horizontal Temperature Distribution across the LSZ (211-245 ft bgs) (temperatures shown in °C)

Figure 13 below shows the observed temperatures by depth at selected LSZ extraction wells.

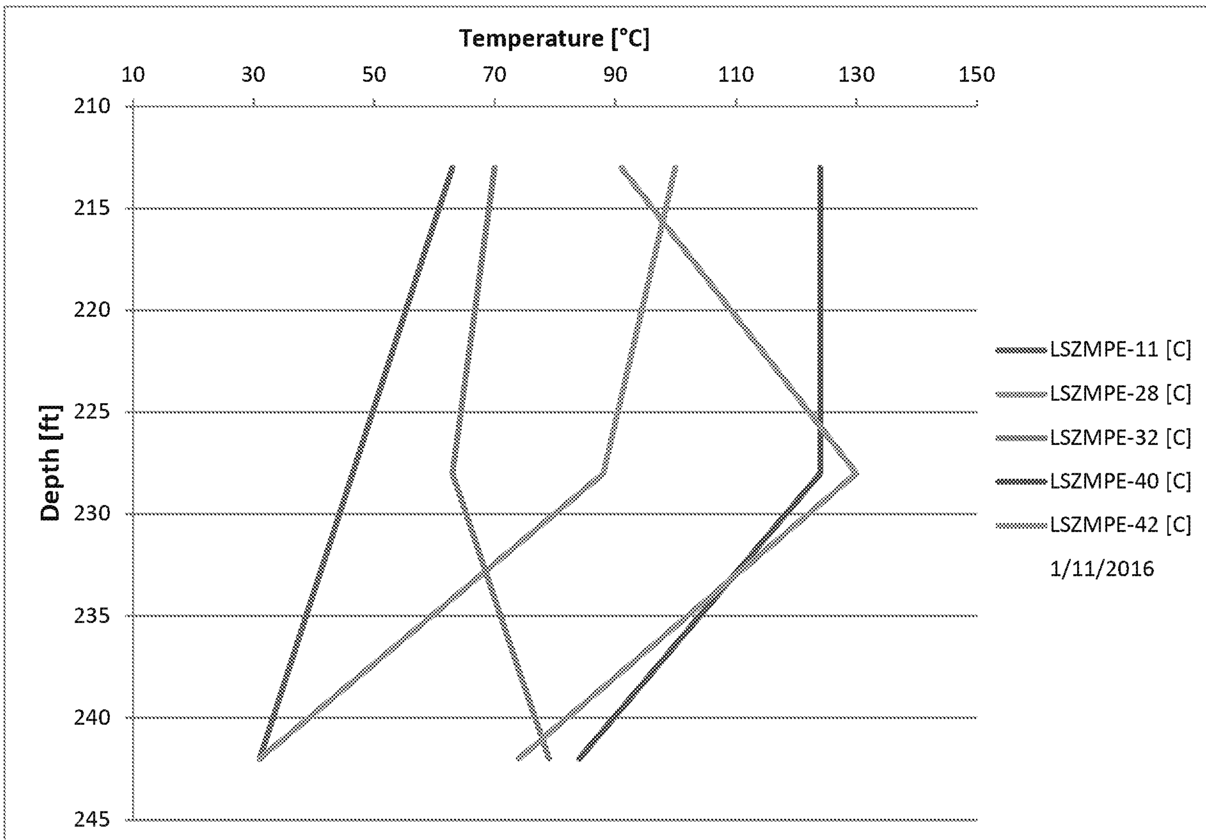

Figure 13. Temperatures by Depth at Selected LSZ Extraction Wells (211-245 ft bgs) (temperatures shown in °C)

9. Cumulative Steam Injection

Steam injection was initiated Thursday, October 16, 2014. Figure 14 below shows the cumulative steam injection for each of the three injection zones.

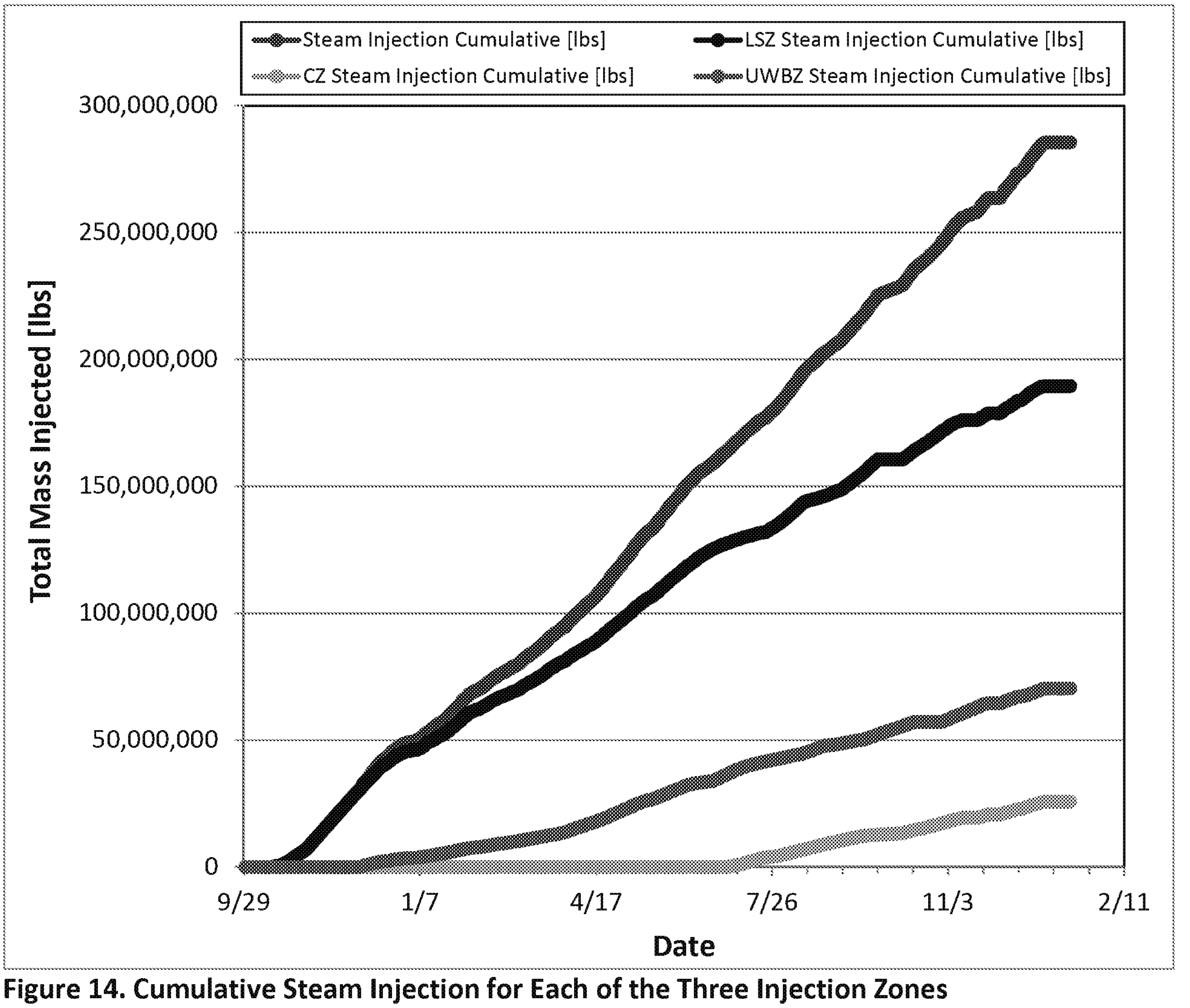

Figure 14. Cumulative Steam Injection for Each of the Three Injection Zones

10. Steam Injection Rates

The figure below shows the steam injection rates for each of the three injection zones.

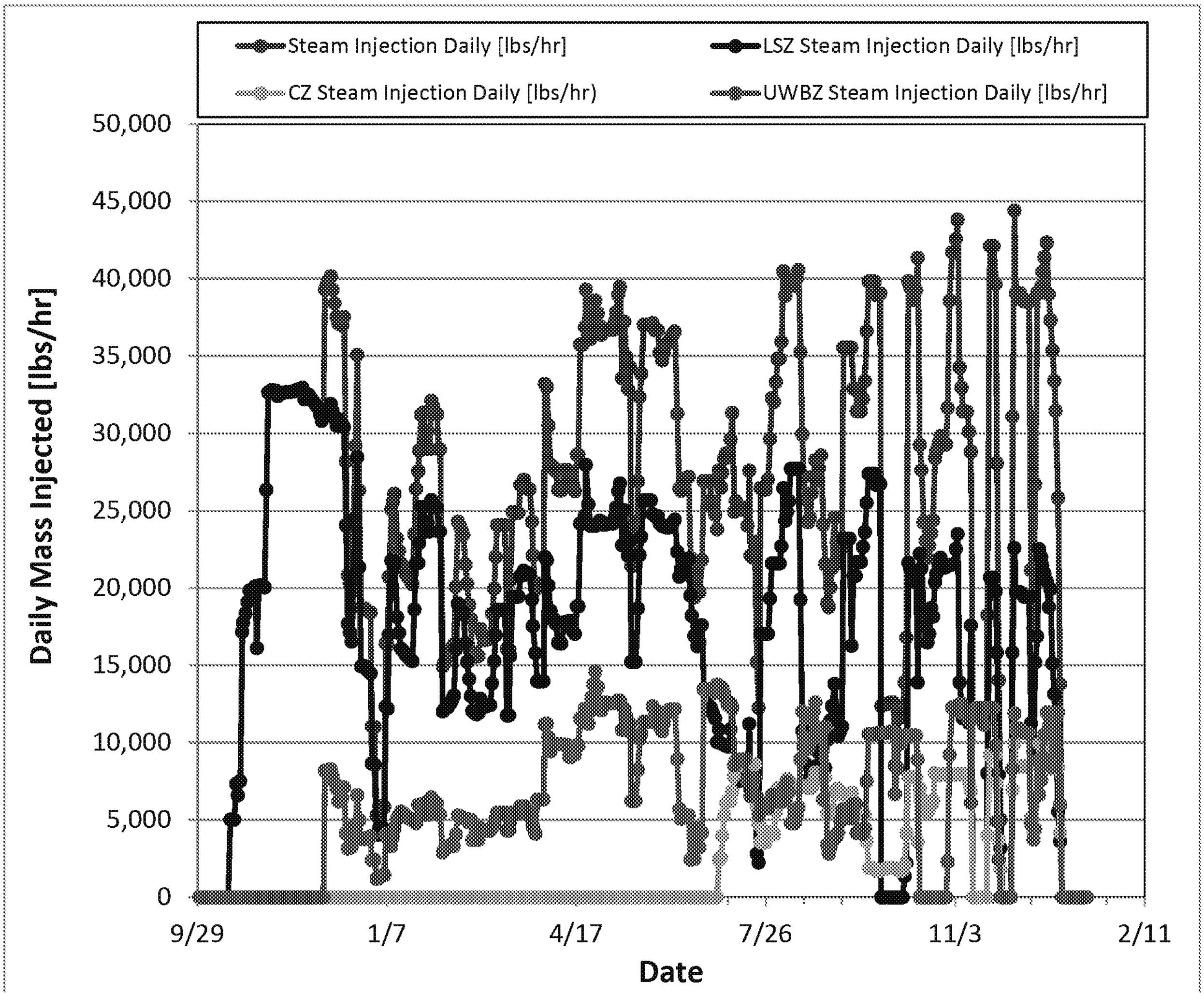

Figure 15. Steam Injection Rate for Each of the Three Injection Zones

11. Cumulative Water Extraction by Zone

The cumulative water extraction for each of the three treatment zones is shown below. The cumulative water extraction is calculated based on flow meters installed at each of the 57 extraction wells (accuracy should be considered +/- 20%). The figure below shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

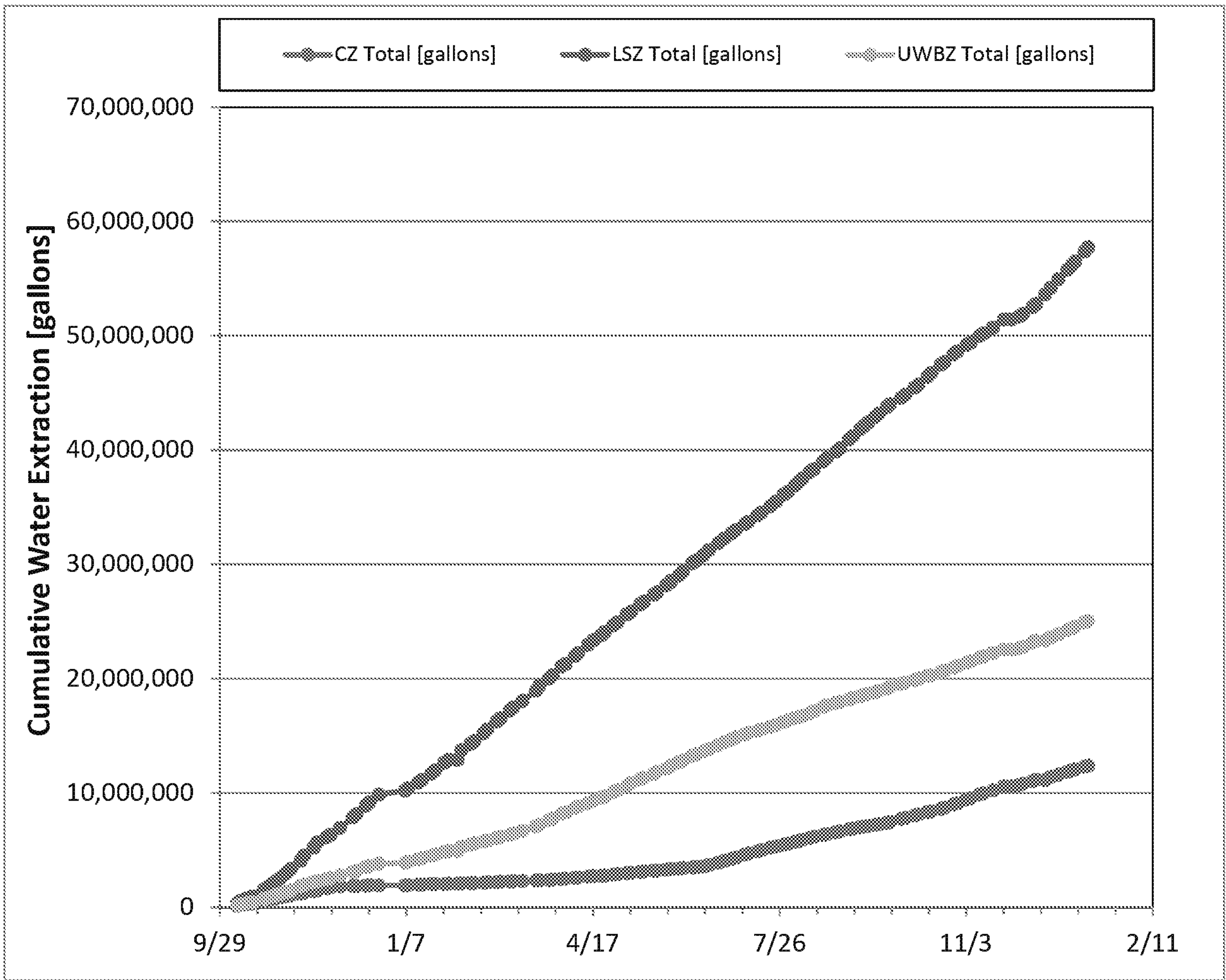

Figure 16. Cumulative Water Extraction for Each of the Three Treatment Zones

12. Water Extraction Rates by Zone

The figure below shows the water extraction rates for each of the three treatment zones.

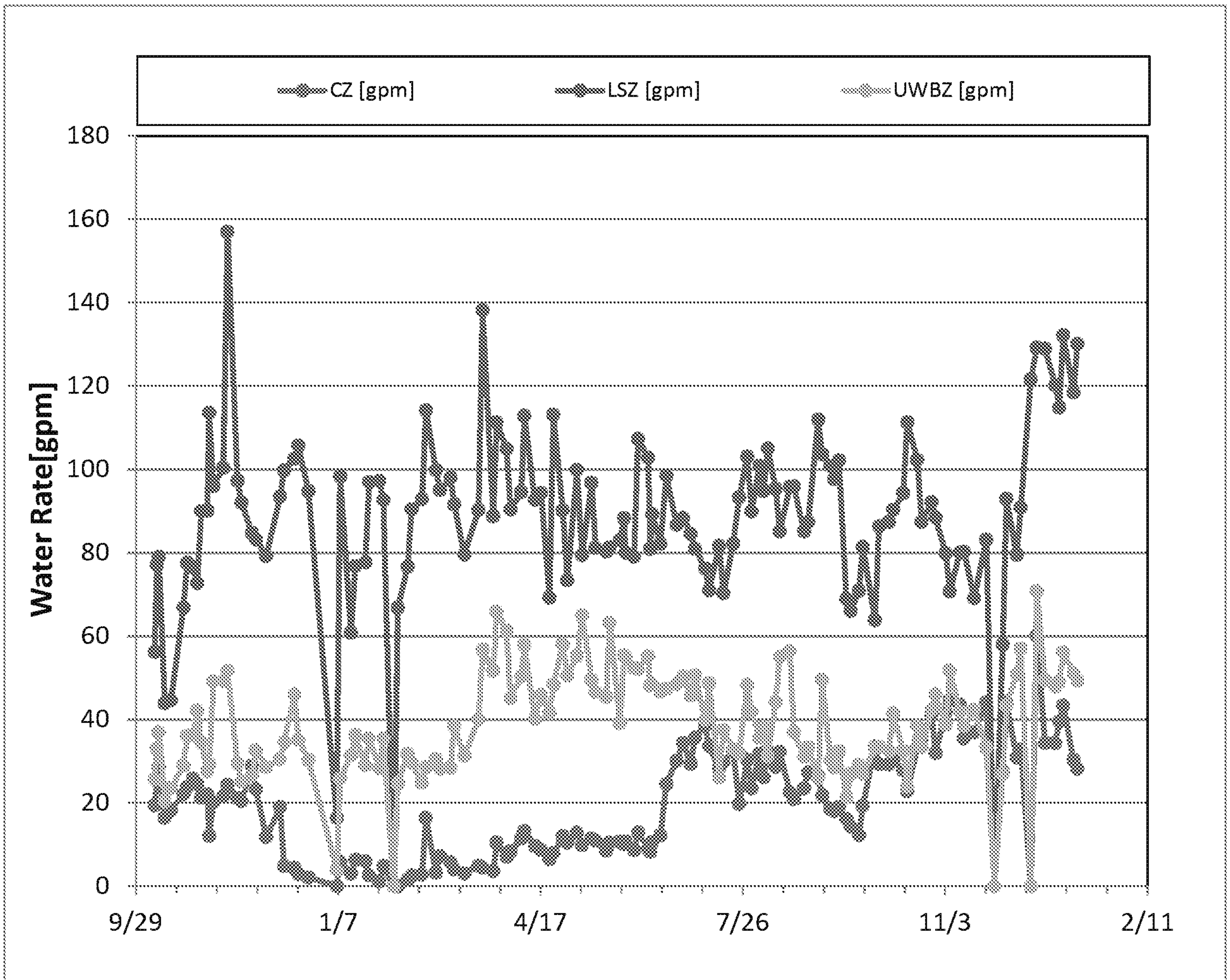

Figure 17. Water Extraction Rates for Each of the Three Treatment Zones

13. Cumulative Water Balance

The cumulative water balance for the site is shown below. The chart shows the net liquid extracted from the subsurface at the site and does not include the fraction of water that is recirculated to the eductor wells and used as motive water.

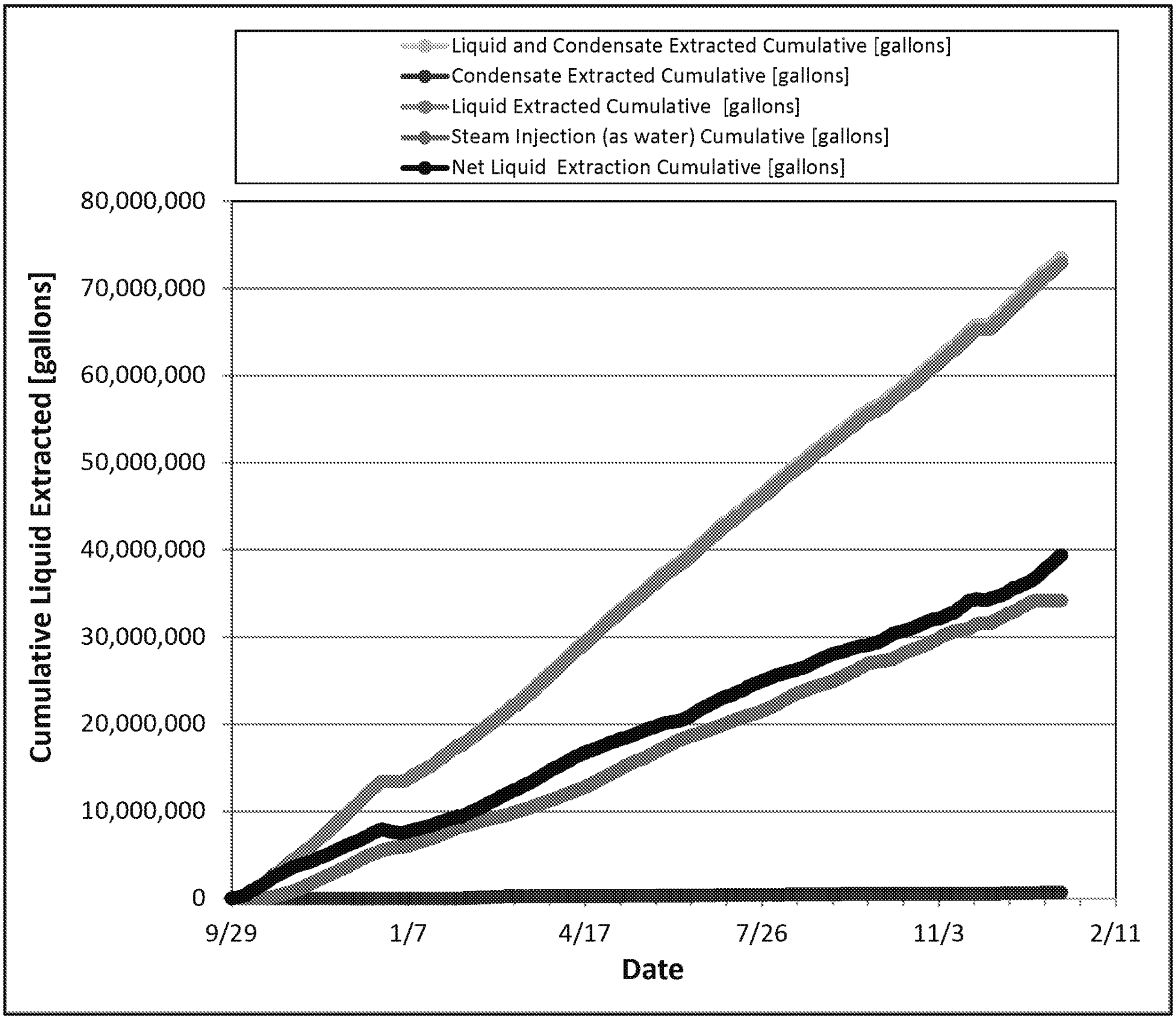

Figure 18. Cumulative Water Balance

14. Water Balance Rate

The total system water extraction rates are shown in the figure below.

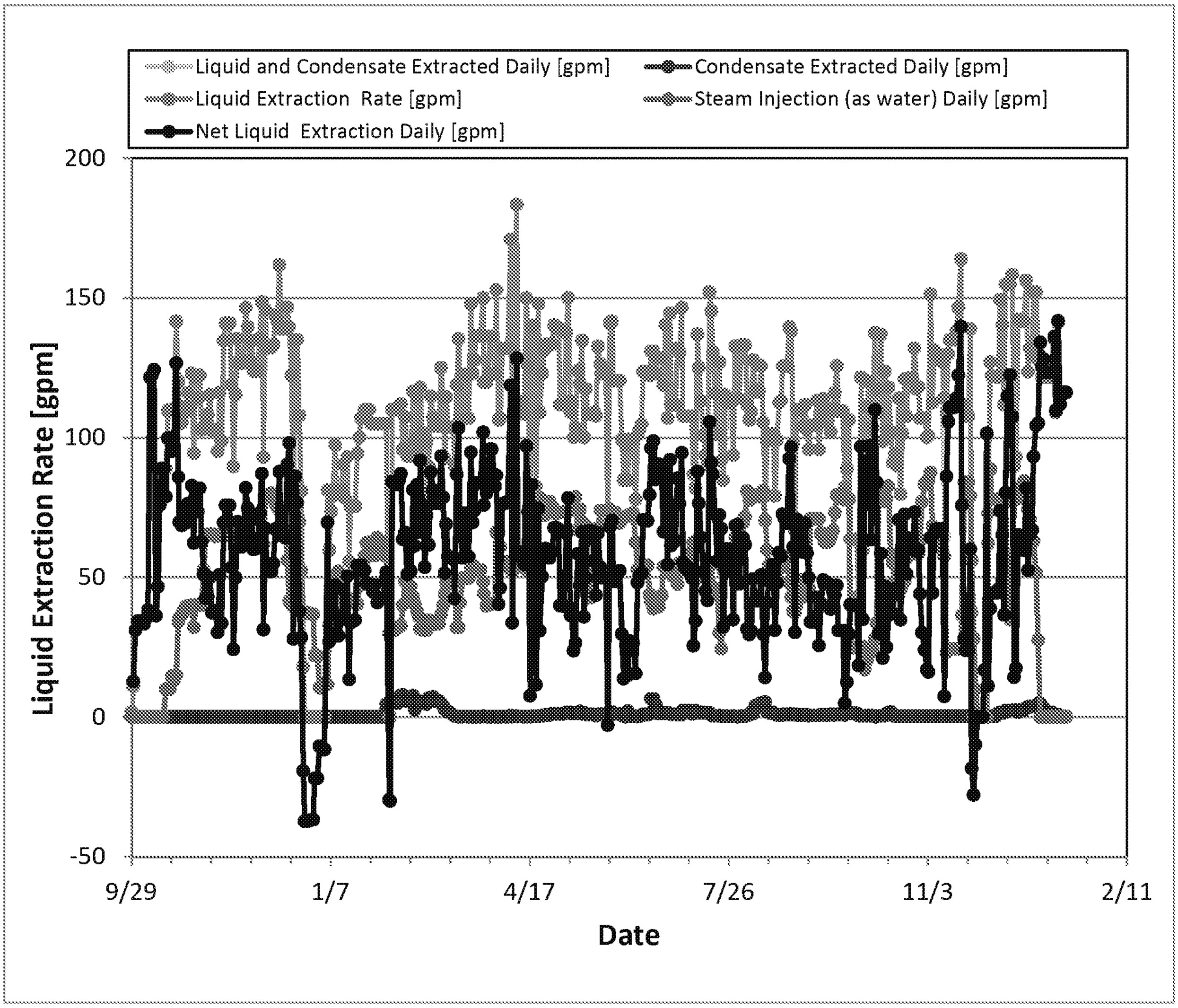

Figure 19. Water Balance Rates

15. Cumulative Energy Balance

The cumulative energy balance for the site is shown below. The energy balance has been updated to include calculated heat losses that are a combination of heat lost below the TTZ, above the TTZ and outside the TTZ. The heat losses were calculated according to the following approach:

- Based on the original SEE model, cumulative modeled heat losses were calculated for each operational phase (i.e., heat up, pressure cycling);
- The heat losses were compared to the cumulative energy added as steam for each operational phase;
- The percent of total steam energy "lost" was calculated by comparing modeled heat losses to modeled steam injection;
- Since the actual steam injection rates at ST012 have been different than originally modeled, the percent heat loss calculated for each operational phase in the model was applied to the actual steam injected to get the calculated heat losses during operation; and,
- The calculated heat losses were subtracted from the net energy injection to calculate the net energy injected with heat losses.

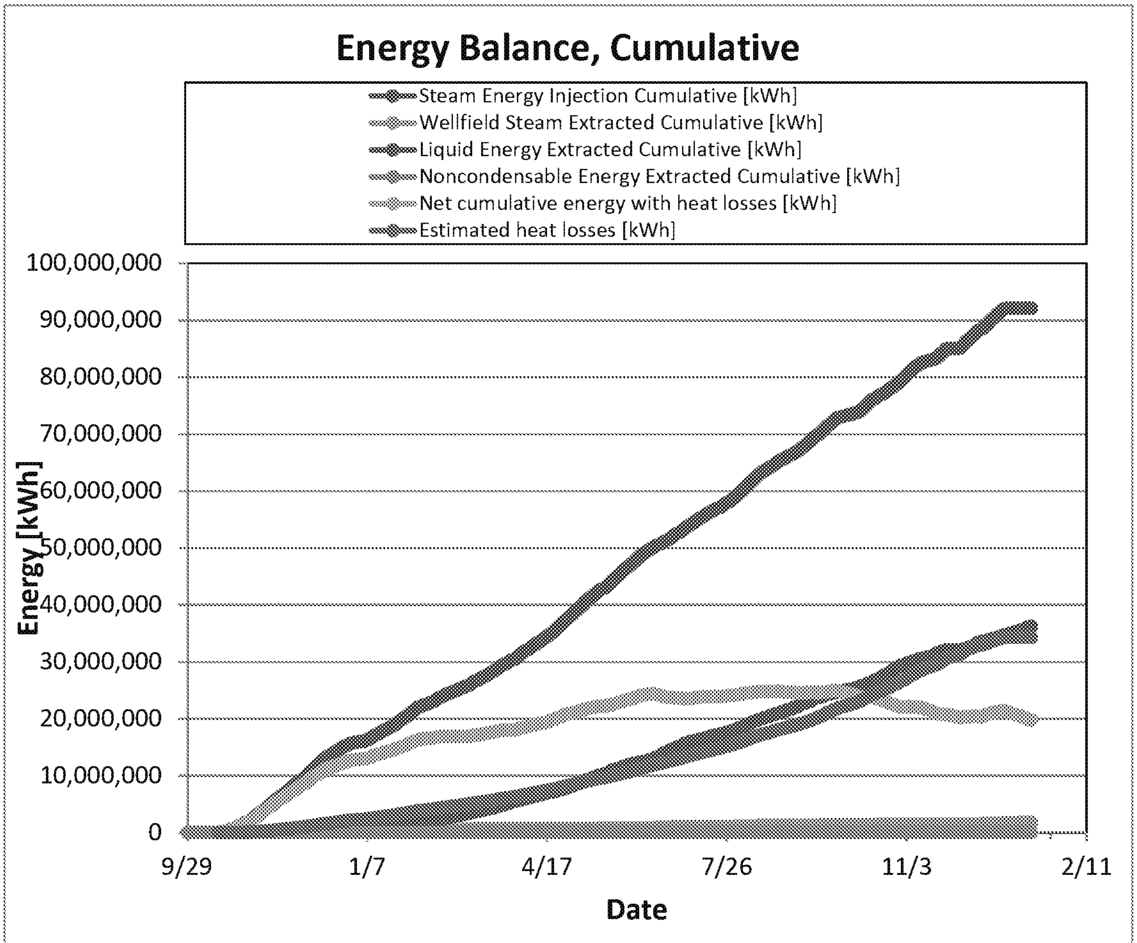

Figure 20. Cumulative Energy Balance

16. Energy Balance Rates

The energy balance rates are shown below.

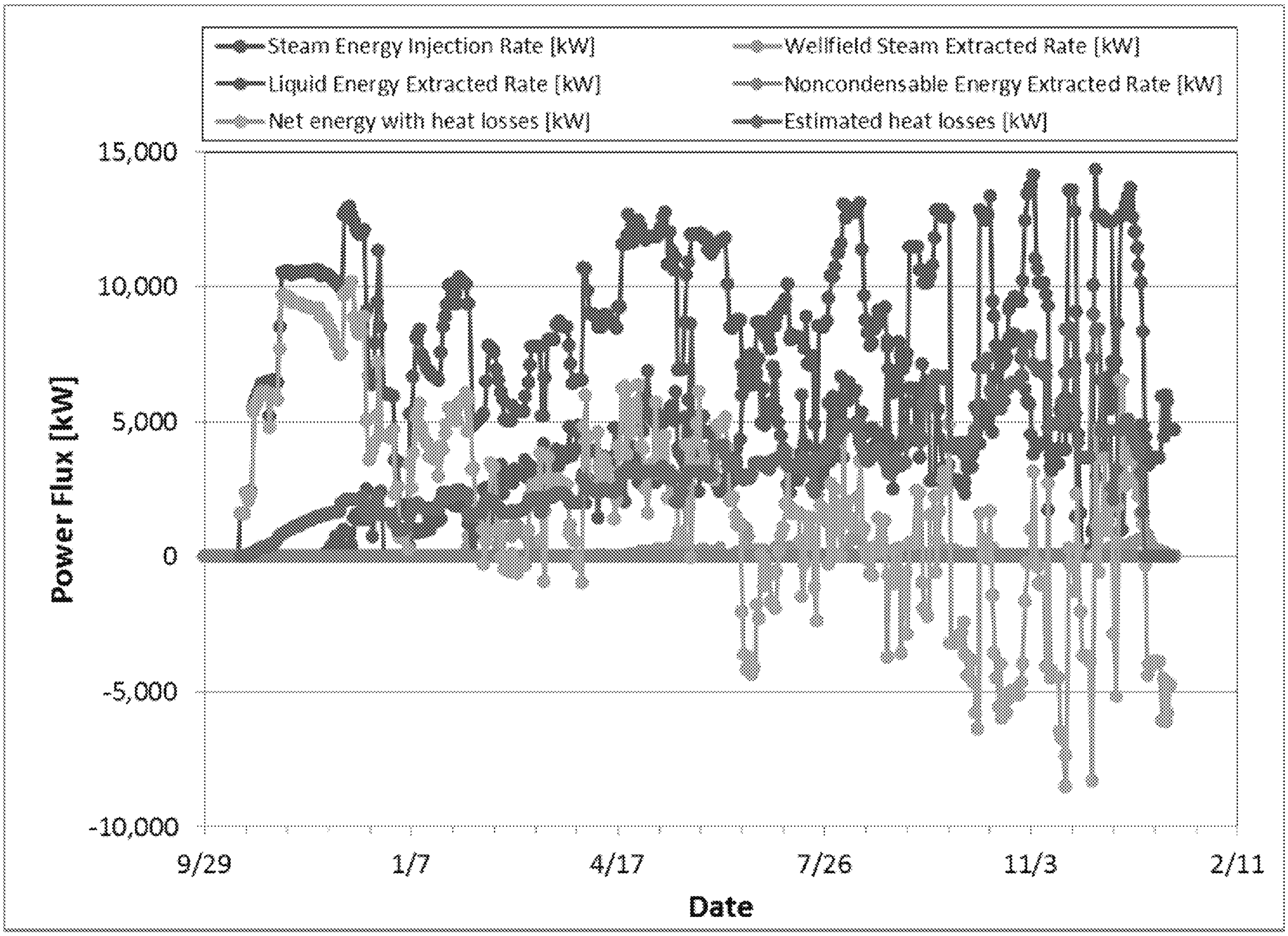

Figure 21. Energy Balance Rates

17. Perimeter Water Level Data

Table 4 below presents the change in perimeter groundwater elevations since SEE system startup. The readings collected on September 24, 2014 (not shown) represent baseline conditions. A negative number shows that the groundwater elevation is lower than the baseline elevation, thus indicating an inward hydraulic gradient into the treatment zone. Liquid extraction began on September 29, 2014. Perimeter water level data are collected on a weekly basis. The regional groundwater table at the Site is increasing at a rate of approximately 1.5 ft/year; thus, each measured value shown in Table 4 has been corrected to take the regional changes into account.

Table 4. Perimeter Groundwater Elevation Changes

	12/18/2015		12/24/2015		12/31/2015		1/8/2016	
Monitoring Well	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous
CZ/UWBZ Wells								
ST012-C01	-1.18	-0.25	-0.99	0.21	-1.07	-0.05	-1.26	-0.16
ST012-C02	-0.79	-0.30	0.53	1.34	-0.79	-1.29	-1.38	-0.55
UWBZ Wells								
ST012-RB-3A	-1.60	-1.20	-0.10	1.52	-1.30	-1.17	-2.55	-1.21
ST012-U02	-1.25	-0.80	-0.29	0.98	-0.77	-0.45	-2.15	-1.34
ST012-U11	-1.41	-0.96	-0.39	1.04	-1.32	-0.90	-2.99	-1.63
ST012-U12	-2.21	-1.82	0.11	2.34	-2.04	-2.12	-4.80	-2.72
ST012-U37	-2.00	-1.82	-3.98	-1.96	-2.03	1.98	-3.03	-0.96
ST012-U38	-1.00	-0.54	-0.32	0.70	-0.54	-0.19	-1.59	-1.01
LSZ Wells								
ST012-W11	-1.52	-1.50	-1.95	-0.41	-6.64	-4.66	-6.94	-0.27
ST012-W12	-1.16	-1.80	-0.42	0.76	-5.98	-5.53	-6.27	-0.25
ST012-W24	-0.69	-1.35	-0.32	0.39	-5.10	-4.75	-5.46	-0.32
ST012-W30	-1.17	-2.17	-0.11	1.09	-5.07	-4.93	-6.57	-1.47
ST012-W34	-0.58	-1.33	-0.17	0.43	-4.52	-4.32	-5.16	-0.60
ST012-W36	0.74	-2.42	0.94	0.22	-4.30	-5.21	-5.69	-1.35
ST012-W37	-2.90	-3.74	0.35	3.27	-4.85	-5.17	-7.26	-2.37
ST012-W38	-0.63	-1.30	-0.16	0.49	-3.95	-3.76	-4.61	-0.62

Figure 22 shows the manually collected groundwater elevation trends since system startup. Additionally Figure 23 shows the groundwater elevations continuously logged in selected perimeter wells equipped with transducers. The regional groundwater table correction has also been applied to Figure 22 below.

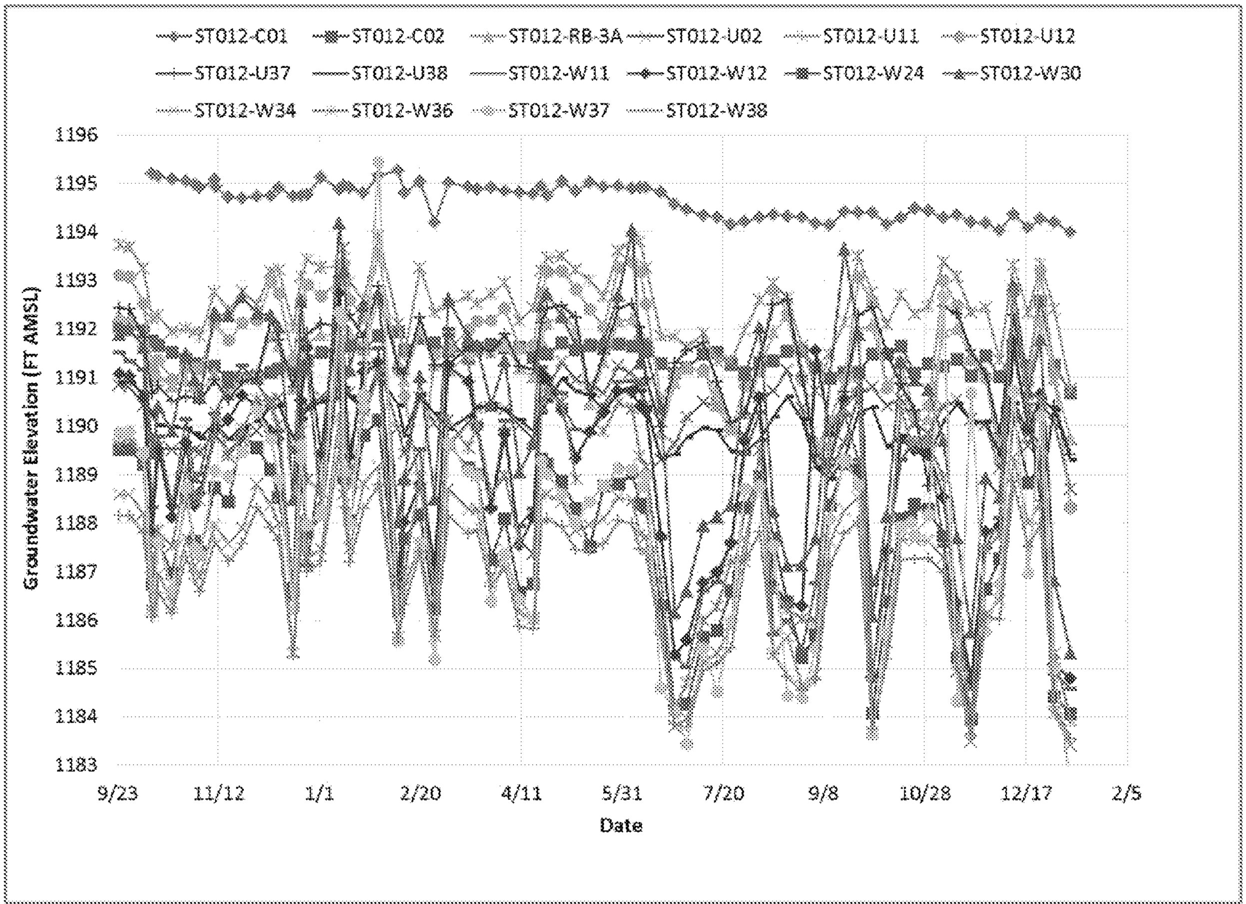

Figure 22. Manually Collected Perimeter Groundwater Elevations

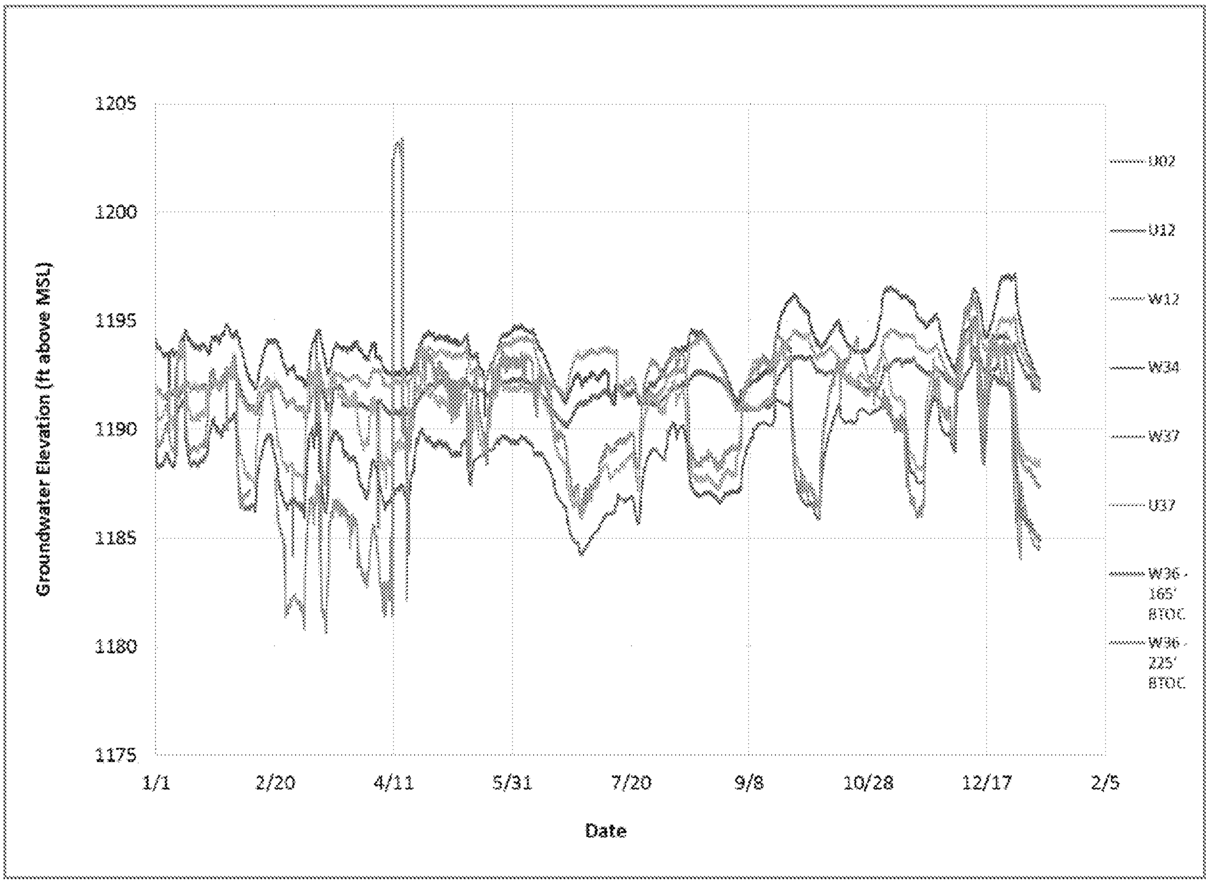

Figure 23. Automatically Collected Perimeter Groundwater Elevations

Table 5 below presents the measured LNAPL thicknesses of the perimeter wells at the site. Perimeter LNAPL thickness data are collected on a weekly basis.

Table 5. Perimeter LNAPL Thicknesses (ft)

Monitoring Well	12/18/2015		12/24/2015		12/31/2015		1/8/2016	
CZ/UWBZ Wells	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing
ST012-C01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-C02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UWBZ Wells								
ST012-U02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-RB-3A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSZ Wells								
ST012-W11	5.47	5.47	6.97	0.17	3.29	3.29	4.72	4.72
ST012-W12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W30	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01
ST012-W34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W37	84.57	9.27	93.41	41.26	81.26	44.98	75.20	25.00
ST012-W38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

On December 1, 2014, temperatures at selected perimeter wells were added to the monitoring program. Figure 24 below shows the manually collected temperatures recorded at the wells included in the monitoring program. Additionally Figure 25 shows the temperatures continuously logged in selected perimeter wells equipped with transducers.

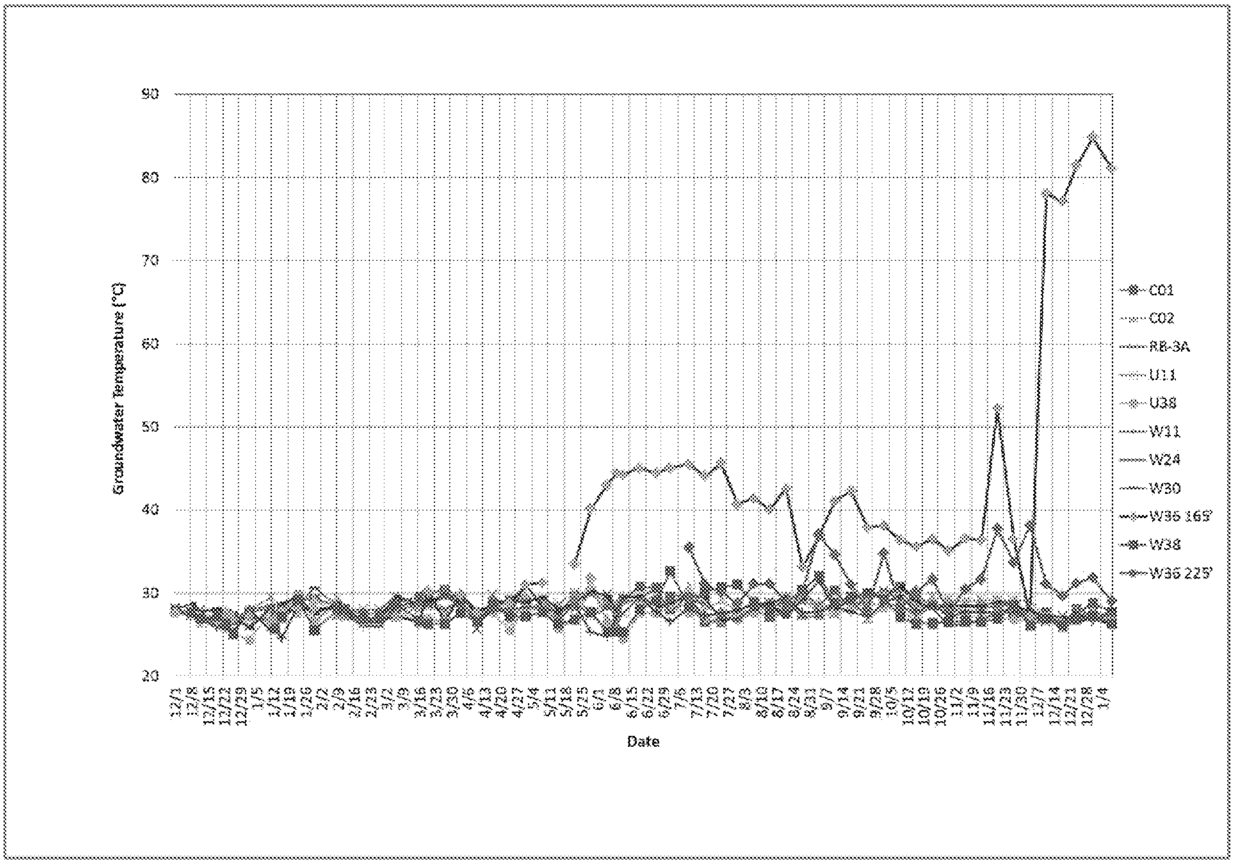

Figure 24. Manually Collected Perimeter Well Groundwater Temperatures

Note: Thermocouples are measured at approximate depths as follows (in feet below top of casing): C01=162; C02=168; RB-3A=161; U11=180; U38=164; W11=228; W24=230; W30=231; W36=225; and W38=228.

As a response to the increased temperatures observed at W36 on December 12, 2015 steam at nearby UWBZ9 and UWBZ25 were decreased.

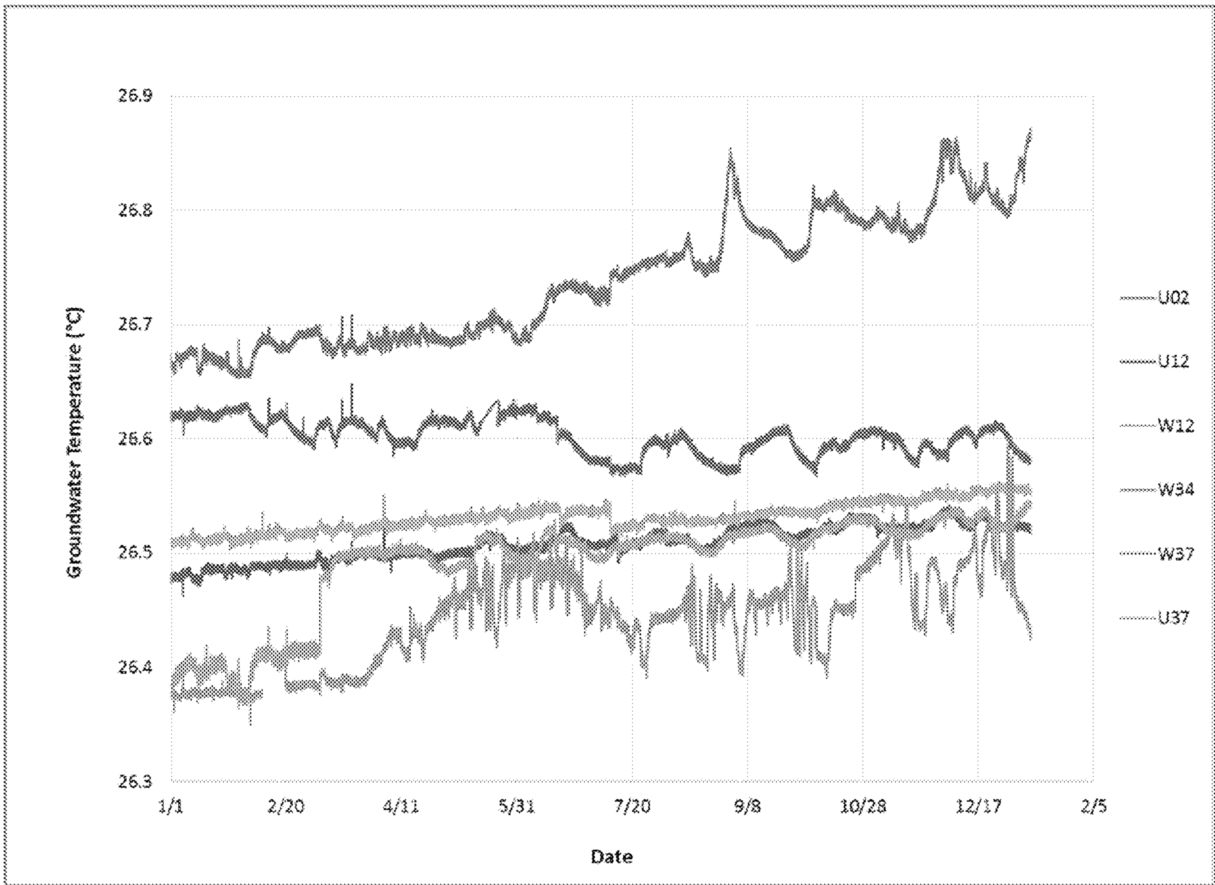

Figure 25. Automatically Collected Perimeter Well Groundwater Temperatures

Notes:

On March 7, 2015 operational personnel replaced the U37 logger unit. The increase in temperature on March 7, 2015 at U37 is a result of this replacement.

Transducers are measured at depths as follows (in feet below top of casing): U02= 175; U12= 175; U37= 182; W12= 228; W34= 225; and W37= 226.

18. Natural Gas Usage

The following figure shows the natural gas usage rate in cubic feet per hour (cf/hr) and cumulative natural gas use in cubic feet (cf) to date at the site.

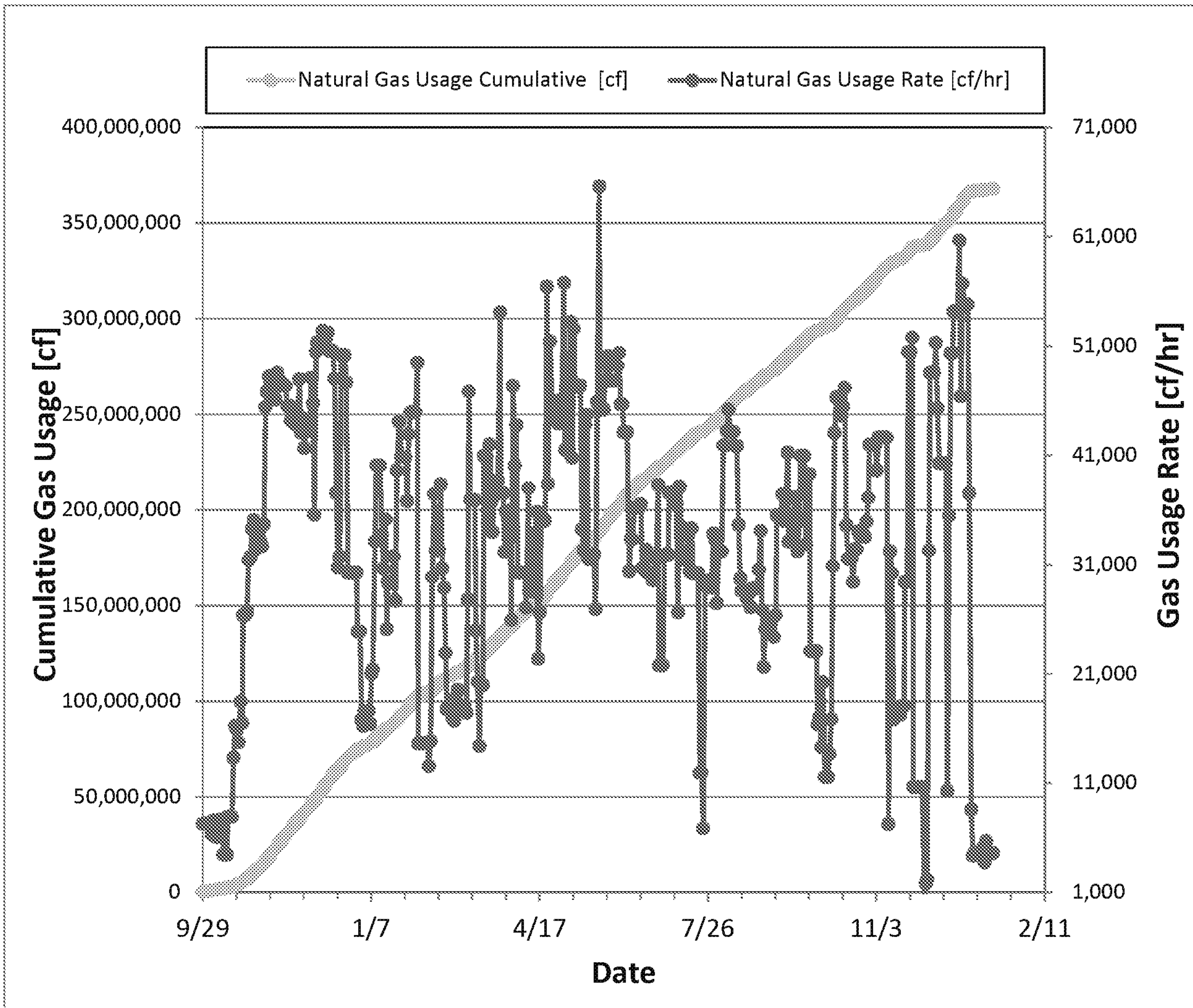

Figure 26. Natural Gas Usage

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19. Waste Generation

On January 19, 2015 a total of 8,033 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 2,857 gallons or 18,800 lbs.

On February 18 and 19, 2015 a total of 24,430 gallons of material from tank cleanout activities was removed from the site by Mesa Oil for recycling. The mass of JP-4 in the material was estimated to be 3,645 gallons or 23,984 lbs.

On March 12, 2015 a total of 11,359 gallons of predominantly water from tank cleanout activities was removed from the site by Mesa Oil for recycling. The JP-4 mass in the water was limited.

On March 20, 2015 the first shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On March 30 and 31, 2015 a total of 32,000 lbs of spent liquid carbon was removed from the site by Evoqua Water Technologies for regeneration at their Red Bluff, CA facility.

On April 24, 2015 a shipment of bag filters (three cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On May 29, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On June 11, 2015 three 55-gallon drums of soil dug from around the Hypro NAPL filter were shipped offsite for non-hazardous disposal.

On June 10, 2015 a total of 5,727 gallons of oily bio-impacted water from tank cleanout activities was removed from the site by Mesa Oil for recycling.

On June 25, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On August 19, 2015 a total of 16,000 lbs of spent liquid carbon was removed from the site by Evoqua Water Technologies for regeneration at their Red Bluff, CA facility.

On August 27, 2015 a total of five totes with approximately 250 gallons each of water/solids from disinfection of the liquid carbon vessel were removed from the site by MP Environmental for disposal.

On October 22, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On November 23, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

On December 31, 2015 a shipment of bag filters (four cubic yard boxes) from the SEE process treatment system was shipped offsite for non-hazardous disposal.

20. NAPL Reuse

On April 7, 2015 a total of 12,647 gallons of stored NAPL was sent to Mesa Oil for reuse. The analysis showed that 703 gallons of the total fluid was water. The water has been subtracted from the NAPL recovery estimate.

On April 21-22, 2015 a total of 13,076 gallons of stored NAPL was sent to Mesa Oil for reuse. Analysis showed a water content between <1% to 3% or a total of 227 gallons of water. The water removed has been subtracted from the NAPL recovery estimate.

On May 7, 2015 a total of 5,722 gallons of stored NAPL was sent to Mesa Oil for reuse.

On May 21, 2015 a total of 1,400 gallons of stored NAPL was sent to Mesa Oil for reuse.

On June 24, 2015 a total of 6,771 gallons of stored NAPL was sent to Mesa Oil for reuse.

21. Estimated Formation Water Temperature

The estimated formation water temperatures are indicated in Table 6 below. The formation water temperatures have been estimated for each MPE well by measuring the eductor liquid feed and return flow rate together with the eductor liquid feed and return temperatures. The enthalpy increase in the liquid return temperature as compared to the liquid feed stream temperature is used to provide the MPE well specific formation temperature. Estimated formation water temperatures above the boiling point likely indicate that steam is being pulled into the liquid extraction system. These estimated data for each MPE well location are used in conjunction with the extracted vapor data collected at the MPE wells to make determinations on steam breakthrough around the site. All of these data are reviewed holistically (with other site data such as the TMP data) to determine when and where steam cycling events should commence.

The location of each MPE well is also indicated in the table. Since perimeter extraction wells are expected to extract colder water from outside of the treatment zone, the formation temperature at these locations is not expected to reach steam temperatures. Thus, full or partial steam breakthrough can still be occurring at the perimeter locations without the estimated formation water temperature being at boiling. Please note that if the estimated formation water temperature is higher than 220°C for a given well, “>220” is indicated in the table.

Please note that no vapor temperature data were collected from the MPE wellheads November 5-13, 2015 due to issues with the temperature equipment.

Table 6. Estimated Well Formation Temperatures

					Formation Temperatures															
Well	Well	Required to Reach	Reached Steam	Vapor Extraction	11/3/15	11/5/15	11/17/15	11/23/15	12/1/15	12/3/15	12/8/15	12/10/15	12/15/15	12/18/15	12/22/15	12/27/15	12/29/15	12/31/15	1/5/16	1/7/16
	Location	Steam Temperature	Temperature (Calculated)	Max Temperature [°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]
CZ07	Perimeter	No	No	158	215	138	205	93		209		114		219	209	>220	>220	>220	205	209
CZ08	Perimeter	No	No	138	186	136	202	194	207	165	183	195		215	205	>220	>220	>220	>220	201
CZ09	Perimeter	No	No	105	131	100		139	141	156	122	124		163	126	159	124	168	131	
CZ10	Perimeter	No	Yes	206	88	111	181	197	176	188	>220	192		199	196	181	213	199	185	186
CZ11	Interior	Yes	Yes	217	>220	159	>220	>220	85					90						
CZ12	Perimeter	No	Yes	220	181	143		201	200	199	179	176							146	179
CZ13	Perimeter	No	Yes	160	177	178	211	178	100	113	212	216		218	>220	>220	>220	>220	>220	198
CZ14	Perimeter	No	Yes	112	>220	197		>220	>220	189	171	>220		204	>220	>220	209	204	171	131
CZ15	Interior	Yes	Yes	170	>220	168	201	210	218	213	>220	217		>220	>220	>220	>220	>220	204	208
CZ16	Perimeter	No	Yes	212	>220	203		>220												
CZ17	Perimeter	No	Yes	200	>220	>220	176	>220	197	157	>220	175		220	214	>220	128	207	201	181
CZ18	Perimeter	No	No	208	174	160	174	105	139		190	125		178	>220				>220	203
CZ19	Perimeter	No	No	110	178	182	181	206	180	175	212	>220		>220	211			199	194	174
CZ20	Outside CZ	No	No	111	81	91	87	88		96	95	92		132	101	104	88	96	88	
LSZ01	Interior	Yes	Yes	126	204	131		219	>220	205	>220	214	>220	>220	159	>220	150	>220	191	209
LSZ02	Interior	Yes	Yes	130	>220	176	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220			200	>220
LZS04	Interior	Yes	Yes	206																
LSZ05	Interior	Yes	Yes	220									213							
LSZ06	Interior	Yes	Yes	218	>220	196		>220	92											
LSZ08	Perimeter	No	Yes	120	>220	>220	>220	>220	>220	>220	>220	>220	>220		151	179	179	160	133	159
LSZ11	Perimeter	No	Yes	119	124		164	215	117	118	125	179	121		113	121	101			
LSZ12	Perimeter	No	No	126	188	130	193	189	167	193	196	194	218	212	210	201	219	204	192	194
LSZ13	Interior	Yes	Yes	125	186	122	195	>220	>220	217	>220	206	209	220	197	70	>220	>220	173	190
LSZ14	Perimeter	No	No	177	218	135	202	198	85			174	>220	>220	159	>220	>220	>220	215	>220
LSZ15	Interior	Yes	Yes	208				>220	>220	>220		>220	>220	205		>220		>220	183	>220
LSZ16	Interior	Yes	Yes	205	183	126	186	182	172	207	>220	>220		>220	279	>220	>220	>220	>220	178
LSZ17	Perimeter	No	Yes	220	115	112	115	110	103	100	113	115	115	117		114	124	113	102	108
LSZ28	Perimeter	No	Yes	129	194	100		173	170	166	184	>220	>220	>220		>220	>220	>220	>220	>220
LSZ29	Perimeter	No	No	116	>220	141	>220	>220	>220	>220	>220	>220	>220		180	219	>220	>220	214	181
LSZ30	Interior	Yes	Yes	133	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220
LSZ31	Interior	Yes	Yes	147	>220	150		>220	187	>220	>220	162		>220	>220	>220	>220	>220	>220	>220
LSZ32	Interior	Yes	Yes	120	>220	150	>220	>220	>220	>220	185	>220	186	>220	>220	>220			159	96
LSZ33	Perimeter	No	Yes	130	208	144	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220	>220		189
LSZ34	Interior	Yes	Yes	168	206	142	>220	>220		>220	>220	>220	>220	>220		>220	>220	>220	220	>220
LSZ35	Perimeter	No	Yes	121	136	126	126	134	118	194	135	134	127	124	135	129	136	112	128	111
LSZ36	Perimeter	No	Yes	128	>220	189	>220	>220		152	92	104	191	188	198	206	101	202	182	179
LSZ37	Perimeter	No	Yes	208	>220	>220	140	200				132	>220		199	>220				113
LSZ38	Perimeter	No	Yes	116	98		147	151	>220		179	>220	112		149	203	188	189	152	193
LSZ39	Perimeter	No	No	118	148	143	135			109	122	130	129		126	161				117
LSZ40	Interior	Yes	Yes	135	>220	>220	>220	>220	>220	>220	>220	205		>220	>220	>220	>220	>220		55
LSZ42	Perimeter	No	Yes	130	201	139	>220	>220	214	205	213	215	>220		211	214		>220	>220	>220

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Formation Temperatures																				
Well	Well	Required to Reach	Reached Steam	Vapor Extraction	11/3/15	11/5/15	11/17/15	11/23/15	12/1/15	12/3/15	12/8/15	12/10/15	12/15/15	12/18/15	12/22/15	12/27/15	12/29/15	12/31/15	1/5/16	1/7/16
	Location	Steam Temperature	Temperature (Calculated)	Max Temperature [°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]	[°F]
UWBZ01	Interior	Yes	Yes	150	201	143		>220	184	>220	>220	>220		>220	>220	>220	>220	>220	>220	>220
UWBZ02	Interior	Yes	Yes	210	84															
UWBZ04	Interior	Yes	Yes	188	>220	182	>220	>220	>220	154	>220	>220		>220	>220	>220	>220	90	>220	>220
UWBZ05	Interior	Yes	Yes	220	>220	165	>220	>220						178		>220				
UWBZ06	Interior	Yes	Yes	165	>220	135	0	170	>220	128	134	146		128	135	132	124	111	107	115
UWBZ10	Perimeter	No	Yes	179	199	144	>220	>220	>220	199	>220	>220		>220	>220	>220	>220	85	>220	115
UWBZ17	Perimeter	No	Yes	220	206	140	>220	>220	213	209	>220	>220		>220	>220	>220	>220	>220	>220	>220
UWBZ18	Interior	Yes	Yes	180	>220	102	195	>220	>220	>220	89			>220	>220	>220	>220	>220	>220	>220
UWBZ19	Perimeter	No	Yes	162	187	132		>220	159	>220	>220	>220		>220	>220	>220	>220	>220	>220	>220
UWBZ20	Dual Phase - Perimeter	No	No	112				187												
UWBZ21	Outside UWBZ	No	No	118	166	112	217	>220	>220	>220	179	>220		194	210	>220	>220	>220	>220	>220
UWBZ22	Perimeter	No	No	127	118	127	207	>220	162	170	187	202		187	181	>220	>220	>220	204	171
UWBZ23	Outside UWBZ	No	Yes	131	212	146	>220	>220	178	>220	>220	>220		211	>220	>220	>220	>220	>220	>220
UWBZ24	Dual Phase - Perimeter	No	No	200	95	30	>220		212	>220	>220	>220		>220	>220				>220	>220
UWBZ26	Outside UWBZ	No	No	105	130	112	131	130		130	>220	127		91						
UWBZ27	Outside UWBZ	No	Yes	115	>220	216	215			115		110		126		170				

RED	: at or above steam temperature (≥210 °F)
GREEN	: below steam temperature (<210 °F)

22. NAPL Screening Results and Calculated Benzene Concentrations

Figures 27-29 below present the screening level results for NAPL detected in samples collected from MPE wells across the site. Screening samples are typically collected on a weekly basis. The figures below also include calculated benzene concentrations of groundwater samples collected from MPE wells across the site.

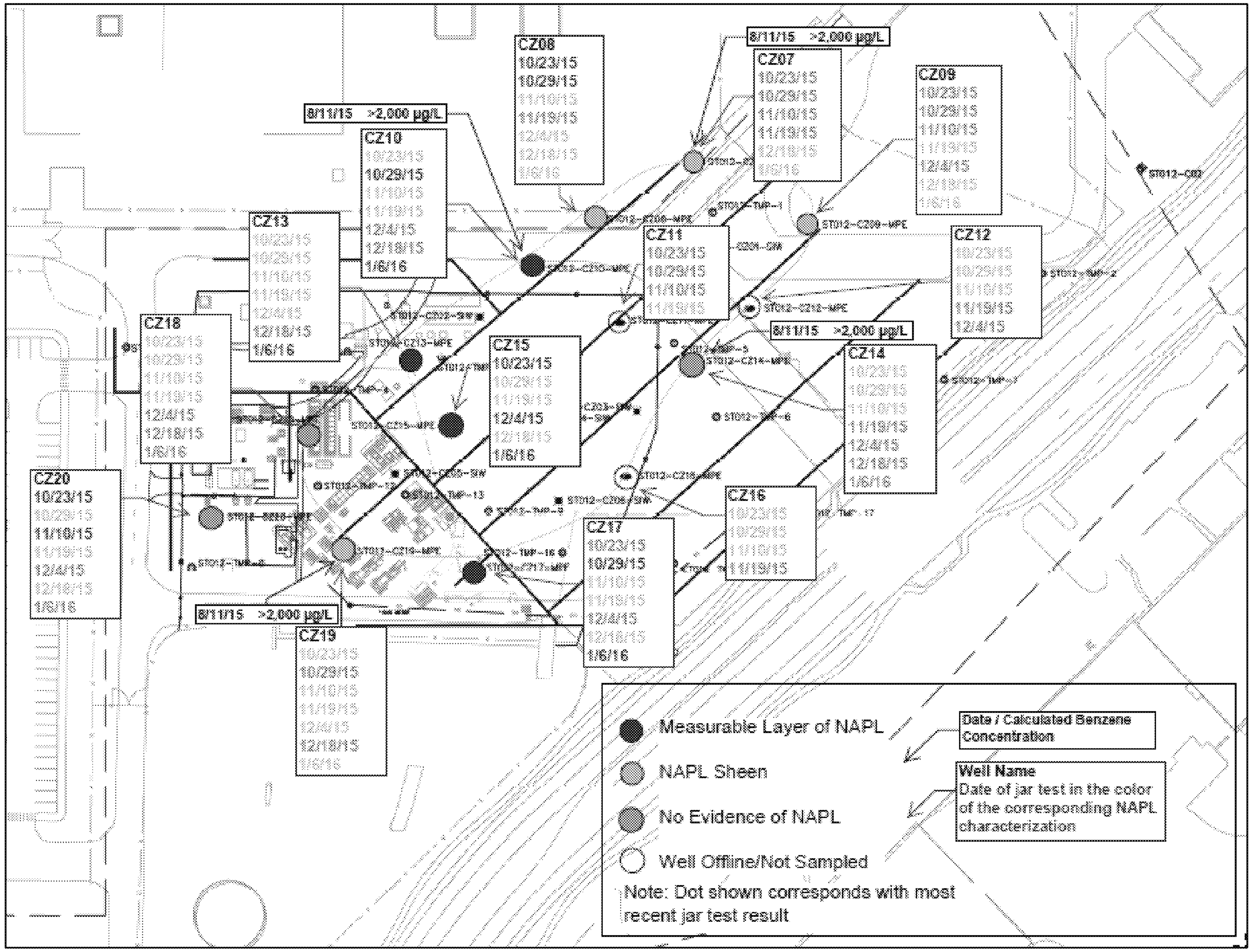

Figure 27. NAPL Screening Results and Calculated Benzene Concentrations – Cobble Zone

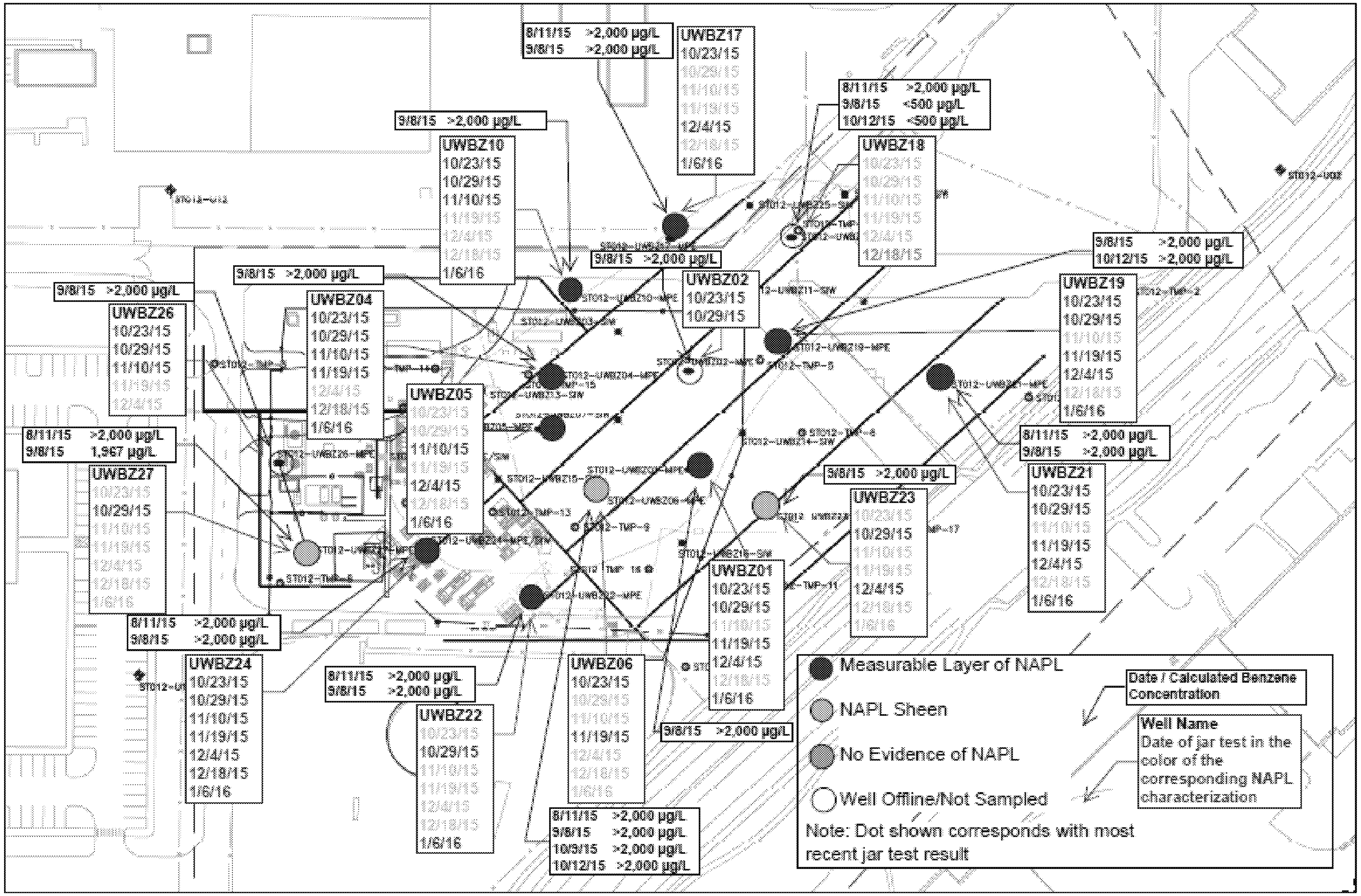

Figure 28. NAPL Screening Results and Calculated Benzene Concentrations – Upper Water Bearing Zone

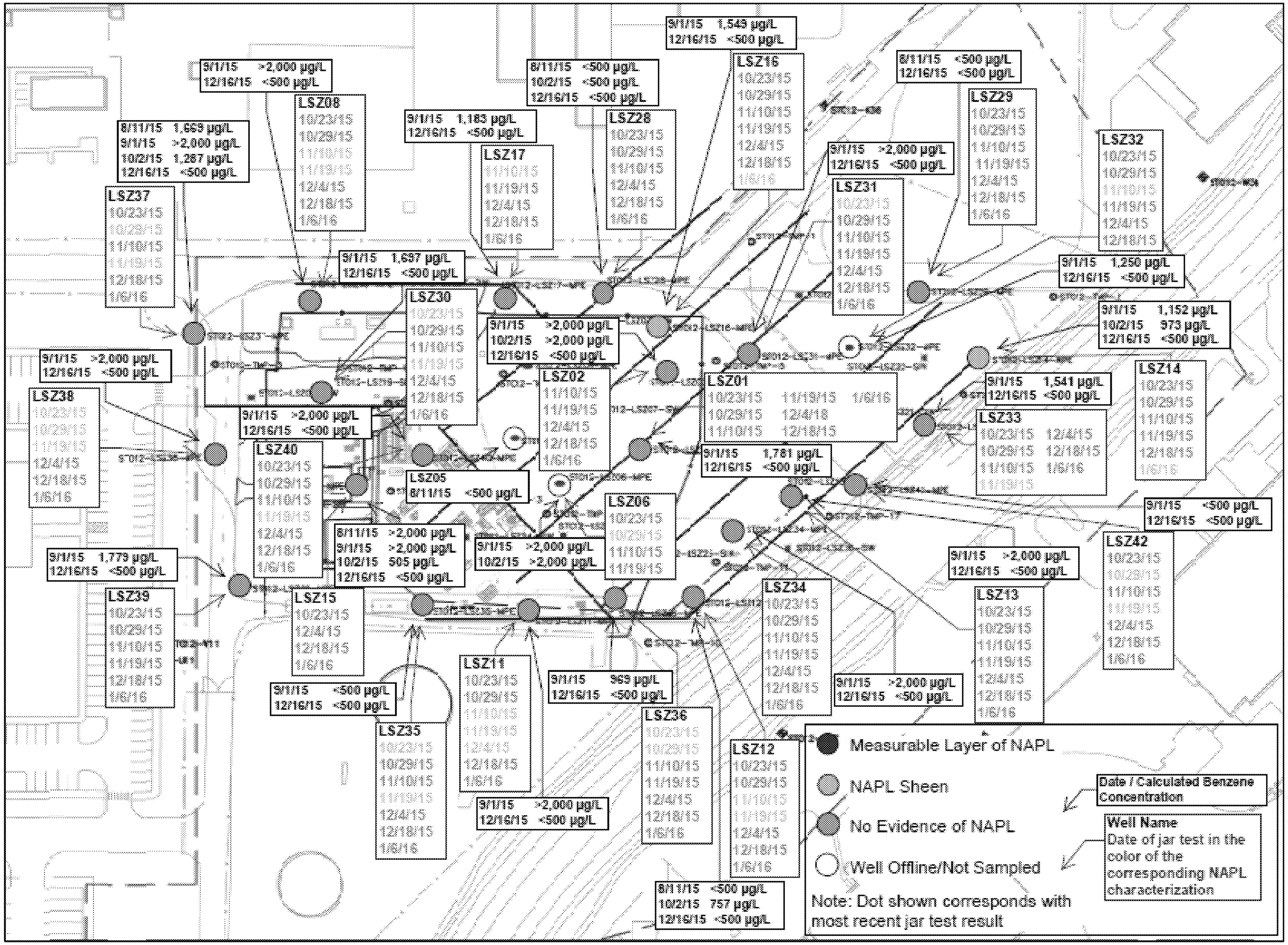

Figure 29. NAPL Screening Results and Calculated Benzene Concentrations – Lower Saturated Zone